REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
24-03-2015	Master of Military Studies Research Paper	September 2014 - March 2015

4. TITLE AND SUBTITLE

Climate Change in the Littorals:
Assessing Impacts to the U.S. Marine Corps in the Face of New Realities

5a. CONTRACT NUMBER
N/A

5b. GRANT NUMBER
N/A

5c. PROGRAM ELEMENT NUMBER
N/A

6. AUTHOR(S)

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5d. PROJECT NUMBER
N/A

5e. TASK NUMBER
N/A

5f. WORK UNIT NUMBER
N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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2076 South Street
Quantico, VA 22134-5068

8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

N/A

10. SPONSOR/MONITOR'S ACRONYM(S)
N/A

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
N/A

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

N/A

14. ABSTRACT

The Department of Defense (DoD) issued the 2014 Climate Change Adaptation Roadmap (Roadmap) that lists several effects of climate change that DoD must assess. Two of the assessment requirements most applicable to the Marine Corps are as follows: 1. How will climate change alter the operating environments? 2. How will climate change affect the demand for DoD capabilities and prioritization of engagements across the range of military operations, with special attention to overseas humanitarian assistance and disaster response missions?

This paper attempts to answer the above questions as they relate to the Marine Corps by exploring the current understanding of climate change and presenting a case study to help answer each question above. Both of the case studies focus on geographically different areas yet provides a common set of impacts to the Marine Corps. Understanding how the operating environment will change and what affect that change will have on future missions is the key to informing sound strategies and adapting to future climate change.

15. SUBJECT TERMS

Climate Change; littorals; Yemen; Marshall Islands

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Marine Corps University/Command a
Unclass	Unclass	Unclass	UU	34	**19b. TELEPHONE NUMBER** *(include area code)* (703) 784-3330 (Admin Office)

United States Marine Corps
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MASTER OF MILITARY STUDY

TITLE:
Climate Change in the Littorals:
Assessing Impacts to the U.S. Marine Corps in the Face of New Realities

Submitted in partial fulfillment of the requirements for the degree of
Masters of Military Studies

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AY 14-15

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LtCol CG-15 15 03 20

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Executive Summary

Title: Climate Change in the Littorals: Assessing Impacts to the U.S. Marine Corps in the Face of New Realities

Author: Major Bryan Patterson, USMCR

Thesis: Climate change will significantly increase the demand for some of the Marine Corps' core capabilities, particularly humanitarian assistance and disaster response missions while drastically changing the shape of the littorals, the Marine Corps' primary operating environment.

Discussion: The Department of Defense (DoD) issued the 2014 Climate Change Adaptation Roadmap (Roadmap) that lists several effects of climate change that DoD must assess. Two of the assessment requirements most applicable to the Marine Corps are as follows:

1. How will climate change alter the operating environments?
2. How will climate change affect the demand for DoD capabilities and prioritization of engagements across the range of military operations, with special attention to overseas humanitarian assistance and disaster response missions?

This paper attempts to answer the above questions as they relate to the Marine Corps by exploring the current understanding of climate change and presenting a case study to help answer each question above. Both of the case studies focus on geographically different areas yet provides a common set of impacts to the Marine Corps.

Conclusion: Understanding how the operating environment will change and what affect that change will have on future missions is the key to informing sound strategies and adapting to future climate change.

Preface

Virtually every overview brief or document on the role of the Marine Corps begins with a discussion of the maritime global commons and the importance of the littorals. These facts are always on display: 70% of the world is water and 75% of the world's population lives within 200 miles of a coast. The Marine Corps' latest capstone concept, *Expeditionary Force 21*, mirrors this approach and reiterates the need to assure littoral access.

Though there is ample national political debate, the effects of climate change receive little attention in the Marine Corps. And I believe that there are fewer regions in the world that will see more impact from climate change than the littorals. The Marine Corps' entire operating environment will be effected and drastically changed in the near future. This spurred my curiosity about what the littorals will actually look like and how that will affect the role and missions of the Marine Corps. And finally, as the defense budget shrinks and fewer platforms are being built, are the current Marine Corps ship to shore platforms adequate for this new environment?

I am a reserve Marine. As a civilian, I manage embassy construction projects for the Department of State, and two of my projects are the US Embassies in the Republic of the Marshall Islands and Yemen. Though they are in drastically different geographic areas, I see first hand how the Department of State is preparing for future climate change in its facilities. These locations provide an ideal backdrop to examine climate change impacts on DOD. One is a low-lying pacific island nation where the US has defense and other financial obligations, and one is an arid region in the Middle East where the US has security interests. Additionally, RMI has a history of amphibious operations in WWII and Yemen is currently in the midst of a crisis where Marines are deployed.

In the end, my goal was to better understand climate change in the littorals and to see how the Marine Corps is postured to meet this new challenge.

Introduction

> The impacts of climate change may increase the frequency, scale, and complexity of future missions, including defense support of civil authorities, while at the same time undermining the capacity of our domestic installations to support training activities.
>
> - Dr. Daniel Y. Chiu, Deputy Assistant Secretary of Defense for Strategy and Force Development

> Climate Change will affect the Department of Defense's ability to defend the Nation and poses immediate risks to U.S. National Security.
>
> - Department of Defense 2014 Climate Change Adaptation Roadmap

> Call it climate change, call it the big blue rabbit, I don't give a hoot what you call it – the military has to respond to these kind of things.
>
> - Brigadier General Mark McLeod, former USPACOM Director for Logistics, Engineering, and Security Cooperation (J4)

The Marine Corps' guidance document, *Expeditionary Force 21* (EF 21), lays out the vision for the Marine Corps for the next ten years and replaces *The Marine Corps Vision and Strategy 2025*.[i] EF21 discusses the future operating environment and indicates that the security atmosphere will be volatile and complex involving state and non-state actors; regional instability will continue to exist through criminal organizations and violent extremist groups; global connectivity and social media will compress the information cycle and increase uncertainty; and the proliferation of cyberspace weapons will erode the US advantage. It is also certain that most of these conflicts will occur in the littoral zones.[ii] Though the basic structure and philosophy of the Marine Corps will continue to ensure its success, EF21 falls short of fully exploring the extent of how future climate change will impact the Marine Corps, its operating environment, and its mission. Climate change will significantly increase the demand for some of the Marine Corps' core capabilities, particularly humanitarian assistance and disaster response missions

within this century. Additionally, climate change will drastically change the shape of the littorals, the Marine Corps' primary operating environment.

DoD Roadmap

The Department of Defense (DoD) recognizes the gravity of future climate change impacts and issued the *2014 Climate Change Adaptation Roadmap* (Roadmap).[iii] The Roadmap acknowledges that climate change is an immediate risk to US national security and details the DoD's adaptation activities as they relate to several broad goals. The Roadmap's first goal is focused on the impacts of current and future climate change in order to identify and assess the effects of climate change on DoD. The Roadmap breaks down the first goal by listing several effects of climate change that DoD must assess. Two of the assessment requirements most applicable to the Marine Corps are:

1. How will climate change alter the operating environments?
2. How will climate change affect the demand for DoD capabilities and prioritization of engagements across the range of military operations, with special attention to overseas humanitarian assistance and disaster response missions?[iv]

This paper attempts to answer the above questions as they relate to the Marine Corps. By exploring the current scientific understanding of climate change, this paper discusses the future environmental conditions that affect the military demand and directly impact the littorals. Additionally, one case study is presented for each assessment question. The Republic of the Marshall Islands (RMI) is discussed to demonstrate the effects of climate change on the operating environment. RMI is a former US trust territory where the US has a current free association agreement with the RMI government practically assuring that the US would assist in a humanitarian operation. RMI was also the site of a World War II amphibious assault. This

provides a historical backdrop to show how the beaches will be altered over time due to climate change. Finally, the Republic of Yemen is discussed to show how climate change will affect the demand for military capabilities across the range of military operations. Yemen is currently experiencing a massive economic, humanitarian, and security crisis, and the impacts of climate change compound each of these crises. Yemen's most scarce resource is also its most important: water. Both of these case studies focus on geographically different areas yet provide a common set of impacts to the Marine Corps. These case studies are sufficient to illustrate that the impacts of climate change have global reach.

Definitions

To ensure a common understanding of the concepts that are discussed in this paper, the following definitions apply:

1. Littorals: The littorals are defined as areas characterized by great cities, well-populated coasts, and the intersection of trade routes where land and sea meet.[v] EF21 describes the littorals as, "congested and diverse areas where the sea and land merge."[vi]
2. Climate Change: The U.S. Environmental Protection Agency (EPA) defines climate change as, "any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer."[vii]
3. Adaptation: DoD is addressing climate change in two ways: through adaptation and mitigation. Adaptation involves planning for the current and expected future impacts. In contracts, mitigation involves reducing greenhouse gas emissions.[viii] This paper focuses on adaptation.

4. Foreign Humanitarian Assistance (FHA) — "Department of Defense activities conducted outside the United States and its territories to directly relieve or reduce human suffering, disease, hunger, or privation."[ix]
5. Amphibious Operation — "A military operation launched from the sea by an amphibious force to conduct landing force operations within the littorals."[x]
6. Operational Environment – "The operational environment is a composite of conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander."[xi]

How will climate change alter the Marine Corps' operating environments?

> About 80% of [the people] today live within 200 miles of the coast, and that trend is increasing as people move towards the economic centers, which are near the ports and facilities that support globalization. So we are seeing a trend of people moving into the littorals.
>
> **- Admiral Samuel Locklear, USPACOM Commander**

Climate change will have impacts in every geographic component commander's area of responsibility (AOR). Taking a detailed look at the United States Pacific Command (USPACOM) provides insights as to what other AORs might face. Because of the low-lying topography, dispersed geography, and coastal population centers, small islands within this AOR are particularly vulnerable to climate change. Pacific islands are also home to the traditional beaches that are most commonly associated with amphibious assaults, especially during the island hopping campaign during World War II. Pacific island beaches will face challenges from sea level rise, severe weather patterns, and food and fresh water shortages as well as refugee and public health issues during this century.[xii] This section will discuss the USMC beach selection criteria for the current inventory of amphibious vehicles. Then, the impacts of climate change on

that criteria will be explored. Finally, a case study is presented that provides real-world implications of a Pacific small island facing the immediate threat of climate change.

Amphibious Assault Beach Selection Criteria

When employing amphibious vehicles in ship to shore movements across a beach, several environmental factors are considered during the intelligence preparation phase of the panning process. Planners gather and assess hydrological information on the landing sites in order to inform the beach selection process. These factors include sea state, natural obstructions, and beach composition. Sea state is a categorization of certain conditions including waves, swell, and surf and is scaled from 1 to 5. Sea state condition 1 includes wind speeds around 5 knots with small wave heights up to 1 foot that do not break. Conversely, sea state condition 5 includes wind speeds up to 25 knots and long, white-capped waves up to 12 feet high. The Amphibious Assault Vehicle (AAV), the Marine Corps main fully tracked landing vehicle, can manage sea states 1-3 effectively. The AAV experiences difficulties in sea state 4 and should not be employed with troops in sea state 5.[xiii]

Natural obstructions at the landing site must also be evaluated to determine if the landing vehicles can navigate the obstacle. Natural obstructions can include reefs, rock outcroppings, sea walls, and sand bars. An AAV, for example, can climb a 3-foot vertical wall on land, but that distance is reduced in the water. When an AAV encounters a vertical obstruction at the landing site, at least 3 feet of water is needed to clear the obstacle. Other factors come into play in these situations such as vertical obstacles that also influence breakers and wave crest heights.[xiv]

The final environmental consideration is beach composition. Beaches can be subdivided into three zones: the foreshore, backshore, and hinterland. The foreshore is the area between the low and high water marks that is typically composed of coarser materials such as gravel, rocks,

or cobblestones and has a steeper gradient. These coarse materials provide poor traction for vehicles such as the AAV. The backshore extends from the high water mark to the vegetation line and can be characterized by a soft and loose composition with a milder gradient. Traction for an AAV is generally better in this zone than the foreshore as well as the gradient. Flat gradients around 1% up to more steep gradients of 7% have little effect; however, moderate gradients around 3% are preferred.[xv] The hinterland is the zone behind the line of vegetation. This zone can present significant trafficability problems for amphibious vehicles as the vegetation can often be dense and the landscape can include many steep obstacles such as dunes and cliffs.

Physical Impacts of Climate Change on Small Island Beaches

The Intergovernmental Panel on Climate Change (IPCC) is an international body established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to assess climate change and provide a scientific view of the impacts. The IPCC Assessment Report (AR) predicts that three climate-related drivers will have the most effect of coastal systems: sea level rise, ocean temperature, and ocean acidity. The AR forecasts that global mean sea level will rise between 0.26 and 0.82 meters by the end of this century.[xvi] Such a rise will dramatically change the geography of the littorals and the beaches themselves including submergence and increased flooding and erosion. In 1962, Geomorphologist Per Bruun developed a rough calculation to determine how much sea level rise will affect coastlines, known as the Bruun Rule. The theory states that the distance the coastline retreats is 100 times the vertical rise of the sea.[xvii] For example, if the sea level rises .5 meters, 50 meters of the beach will be submerged. Though the Bruun Rule is two-dimensional and has been subject to debate and modification, it shows the basic scope and scale of the impact of sea level rise on coastlines.

Ocean temperatures and acidity are expected to increase as well, which leads to coral bleaching and mortality. As a result, coral reefs are severely vulnerable to climate change. Coral reefs are an integral part of the coastal ecosystem as they provide stability and shoreline protection, especially in the tropic and sub-tropic regions of the Pacific. The absence of these reefs will lead to reduced biodiversity of species within the coastal ecosystem as well as flooding and erosion. Each of these climate-related drivers will have a direct impact on the physical characteristics of the beaches including the three environmental factors (sea state, natural obstructions, and beach composition) for selecting a beach for an amphibious assault. An overview of the effects is provided in the below table[xviii]:

Beach Selection Factor	Climate-Related Driver	Physical Effects	Impact on Potential Landing sites
Sea State	Sea level rise High winds High waves	Coastal erosion Salt water incursion Wind waves Storm surges	Submerged backshore Steeper gradient
Natural Obstructions	Sea level rise Higher ocean temperature Increased ocean acidity	Reef Mortality Coastal erosion	Degraded foreshore Steeper gradient
Beach Composition	Sea level rise Severe Storms	Decreased sediment delivery Flooding Coastal Erosion Coarse composition	Poor traction Steeper hinterland

Table 1: The effects of climate-related drivers on beach selection factors and the impact on potential beach landing sites.

The Republic of the Marshall Islands, A Case Study

> Either you climb a coconut tree and stay up there for the rest of your life…or you migrate.
>
> - John Silk, Minister of Foreign Affairs for the Republic of the Marshall Islands

USPACOM is home to 11 Asia-Pacific small island chains (Fiji, Kiribati, Marshall Islands, Micronesia, Nauru, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu). Assessing the challenges facing the Republic of the Marshall Islands (RMI), an island nation about 2500 miles southwest of Hawaii, serves as a example of climate change challenges the Marine Corps can expect from other Asia-Pacific small islands. Though the RMI is not a U.S. territory, the U.S. has legal responsibilities regarding defense, emergency response, and other civil assistance. With Public Law 99-239, Congress approved the Compact of Free Association with the RMI (and the Federated States of Micronesia) on January 14, 1986. That resolution terminated the International trustee system put in place by the United Nations and reiterated the commitment of the U.S. to providing assistance and promoting development and self-government within those territories.[xix] On December 17, 2003, Congress passed a new law (Public Law 108-188) that amended the previous Act and appropriated funds for the next 20 years. The Compact of Free Association Act of 2003 is divided into four titles that define the relationship between the U.S. and the RMI:

1. Title I. Government Relations
2. Title II. Economic Relations
3. Title III. Security and Defense Relations
4. Title IV. General Provisions[xx]

The United States will continue to provide nearly $70M annually through 2023 and has responsibility for the security and defense of the RMI, and the U.S. continues to pay reparations for the nuclear tests conducted at the Bikini and Eniwetok atolls during World War II.[xxi] Additionally, several U.S. Governmental agencies operate in the RMI including the Federal

Aviation Administration, the U.S. Postal Service, the Small Business Administration, the U.S. Agency for International Development, the Department of Energy, the Department of Agriculture, the Department of Health and Human Services, the Department of Education, the Department of State, and the Department of the Interior.[xxii] The compact of free association does not address climate change specifically. However, due to the history between the RMI and the U.S. and the heavy involvement of other U.S. agencies, the DoD can expect to provide support to the RMI in the event of a climate change related emergency.

Impact on DoD Facilities

The DoD maintains a major presence in the RMI as the U.S. Army operates a multi-billion dollar missile test range on Kwajalein Atoll. The Ronald Reagan Ballistic Missile Defense Test Site (RTS), a subordinate command of the U.S. Army Space and Missile Defense Command, is the second largest employer in the RMI.[xxiii] Because of its strategic location and specialized instrumentation, RTS is a vital asset that provides research, development, testing, and evaluation of defense and space programs.[xxiv] Adverse climate change impacts would not only have a negative effect on the local economy but they would also degrade or force the relocation of the DoD's missile capabilities and the RTS functions.

Impact on Human Health

The RMI consists of five islands and 29 atolls from two different archipelago island chains and is home to nearly 71,000 people. The total land mass is equivalent to Washington, D.C., but the low lying islands and atolls spread out over 750,000 square miles of ocean.[xxv] Because of these geographic conditions, significant changes in temperature, precipitation, or wind will have dramatic effects on the RMI. Additionally, a dispersed population with an already limited health care system presents challenges for humanitarian relief personnel and public

health officials. In fact, worst-case predictions render the RMI uninhabitable.[xxvi] Regardless of the severity, any of the climate change scenarios in the Marshall Islands would likely require DoD involvement in humanitarian assistance and disaster relief operations.

The IPCC has established a direct link between climate change and an increase in certain diseases such as malaria and dengue fever.[xxvii] Mosquitoes, the vector that carries the disease, lay their eggs in standing water. More storms, flooding, humidity and precipitation lead to a greater number of hatches. Climate change indirectly contributes to other adverse human health affects as well. For example, as severe storms damage homes, businesses and economic livelihood, stress will increase. Fresh, clean water and adequate nutrition tend to become limited which leads to a decline in overall health.[xxviii] Climate change makes containing the disease more difficult and compounds the humanitarian crisis, especially on small islands such as RMI.

A Case in Point

In October 2011, the government of the RMI declared a state of emergency after identifying three cases of dengue fever. This was the first recorded outbreak of the disease in the RMI, and just two months later, 1,360 cases were reported over four RMI atolls. The US Agency for International Development's office of U.S. Foreign Disaster Assistance (USAID/OFDA) led the response along with the World Health Organization (WHO) and several other U.S. agencies including U.S. Centers for Disease Control (CDC) and DoD.[xxix] DoD sent the U.S. Naval Medical Research Unit No.2 (NAMRU-2). NAMRU-2 is an overseas Navy lab that conducts research, surveillance, and outbreak response to the PACOM AOR. The 5-man team worked through the island chain by applying pesticides and also conducting an educational outreach program. The intent of the program was to teach the Marshallese how to spray for mosquitoes and how to reduce the locations where mosquitoes can breed.[xxx]

All told, the RMI draws over $100,000 from a joint US-RMI disaster assistance fund. USAID/OFDA awarded another $750,00 to a regional disaster management program for training and education. Following the crisis, USAID/OFTA began prepositioning relief supplies such as water purification equipment, water storage options, health supplies, and generators throughout the island chain. This crisis also prompted USAID to work with RTS to enhance the response capacity of the U.S. Army installation and to update their emergency action plans for severe weather events and other emergencies.[xxxi] Though this crisis started with just three cases of the disease, the response to the dengue fever outbreak shows that a coordinated effort can be effective in FHA operations. However, a significant U.S. response is required and severe weather events, temperature variations, and other climate change variables will make these cases more complex and likely in the future.

WWII Amphibious Assault on Kwajalein

Future climate change will drastically alter the landscape of the RMI and threatens the habitability of the nation. Had these forecasted climate change impacts happened just a few decades earlier prior to World War II, the association between the RMI and the United States might not have happened. The United States conducted a series of amphibious assaults in the RMI during the war against Japan. After the US military captured the Tarawa atoll in the Gilbert Islands during November 1943, the next stop in the island hoping campaign in the Pacific theater was the Marshall Islands. Code-named Operation Flintlock, the Marshall Islands represented a strategic naval base and communications hub for the Japanese. Vice Admiral Raymond A. Spruance, Commander of the 5th fleet (Task Force 50) was in charge of the operation, and Rear Admiral Richmond K. Turner commanded the amphibious task force called the Joint Expeditionary Force (Task Force 51). Major General Holland M. Smith commanded the landing

forces once ashore called the Expeditionary Troops (Task Force 56). Smith had more than 80,000 troops for the operation and assigned the assault on Kwajalein to the 7th Infantry Division commanded by Major General Charles H. Corlett. Smith tasked the 4th Marine Division, commanded by Major General Harry Schmidt, to assault Roi and Namur atolls further north in the Marshalls.[xxxii] Roi and Namur fell quick to the 4th Marine Division, but Kwajalein proved to be more challenging. The assault on Kwajalein began on February 1, 1944 with an amphibious assault across the lagoon side beaches on the western end of the island and ended on February 4, 1944 when the US successfully securing the eastern end.

The Japanese were forced to defend the beach landing sites in a linear fashion with limited depth because the island was only 2.5 miles long and 880 yards wide; therefore, they were more susceptible to pre-assault fires. Additionally, they also chose to more heavily defend the ocean side of the islands rather than the lagoon side. The ocean side of the atoll is subject to high surf, strong winds, and a relatively narrow reef. The lagoon side is much calmer, with smooth water, but a much larger and wider reef with rock outcroppings. The Japanese did not think that the US forces had the capability to land in those conditions. Early reconnaissance of the potential landing beaches indicated that the ocean side was more heavily defended.[xxxiii] Two beaches on the western edge of Kwajalein were designated as the primary landing sites: Red Beach 1 and Red Beach 2. Both beaches were approximately 300 yards long by 40 yards wide with a gentle slope of soft sand protected by a coral reef. The Japanese had prepared some defenses in the area including breastworks, trenches, and pillboxes. However, improvements in US tactics and equipment allowed the landing troops to gain the initial foothold at Red Beach 1 and 2 that facilitated the rest of the assault across the Island.

In the end, 142 Americans and nearly 5,000 Japanese were killed in the battle for the Kwajalein. The victory validated the amphibious doctrine and tactics that the US had continued to develop since Tarawa. The command relationships between amphibious forces and the landing forces were made clearer during this operation and proved effective as well. The invasion on Kwajalein combined unprecedented and overwhelming pre-assault fires from the air and sea and a landing force of over 40,000 men being brought to shore in improved amphibious platforms that could navigate the outer lying coral reefs of the lagoon. The invasion also served as the first capture of pre-war Japanese territory as set the stage for future assaults in the island hopping campaign.[xxxiv]

How will climate change affect the demand for Marine Corps capabilities?

> The military could be called upon more often … to provide humanitarian assistance and disaster relief in the face of more frequent and more intense natural disasters.
>
> **- Chuck Hagel, Secretary of Defense**

Military operations are categorized into three broad areas:

1. Military engagement, security cooperation, and deterrence;
2. Crisis response and limited contingency operations; and
3. Major operations and campaigns.[xxxv]

Figure 1, below, depicts the range of military operations plotted against a conflict continuum and shows that major operations and campaigns often involve combat and occur more on the war end of the scale. Conversely, military engagements, security cooperation, and deterrence operations often occur in a peacetime environment. These operations are undertaken to assist and cooperate with partner nations with the aim of mitigating or deterring conflict. Crisis response and limited contingency operations can occur at both ends of the continuum depending on the circumstances.

These operations also vary in the level of complexity and duration and are undertaken to address a threat or alleviate the effects of a threat or disaster.[xxxvi] This section will look at how future climate change will increase the demand for the Marine Corps across each category of military operations, although the scale of the demand varies. A case study is also provided that discusses a failing State in the midst of a security crisis and how climate change compounds the problem.

Figure 1: Range of Military Operations[xxxvii]

Military engagement, security cooperation, and deterrence

The increased demand for military engagement, security cooperation, and deterrence operations will be moderate (Table 2). Regional instability and conflict will likely rise as resources become strained. Additionally, the activity in some AOR's of geographic component commands will likely increase as the melting polar ice caps give way to new shipping lines and border disputes at new littoral chokepoints. These conditions will warrant the Marine Corps'

employment to support partner nations, intergovernmental organizations, or even non-governmental organizations to deter or mitigate the source of the conflict and to focus on common security goals.[xxxviii] Of slightly greater concern is the reverse effect. Interstate conflicts in volatile regions make many nations more vulnerable to climate change. Violent conflicts often lead to displaced people, resource shortfalls, economic decline and degraded infrastructure. Directing resources and assets to remedy these issues means less will be available if climate change impacts are felt concurrently or after the conflict is resolved.[xxxix]

Crisis response and limited contingency operations

The increased demand for crisis response and limited contingency operations will be severe. The Marine Corps can expect to see a significant increase in the number, scope, and complexity of FHA operations, in particular. Climate change increases and intensifies extreme weather events that stress already limited resources in most regions around the world. Extreme weather events such as heat waves, floods, droughts, tropical storms, typhoons, tornadoes, etc. drastically alter food supply and production systems, damage infrastructure and personal property, provide vectors for the spread of diseases, and limit available fresh water. As a consequence, entire communities are at risk and the demand for an international response will increase.[xl] Validating this point, the National Defense University conducted a series of war games using climate change as the major source of conflict. The war gaming concluded that climate change is a catalyst for food and fresh water shortages, flooding and other hydro-meteorological disasters, and population displacement and public health issues.[xli] To alleviate the suffering and prevent these situations from escalating, the Marine Corps, and other US services, will likely be called upon.

Major operations and campaigns

The increase in major operations and campaigns due to climate change will be minor. However, if the extreme weather events are severe enough and cause enough damage, FHA could be elevated to a major operation where some security operations or combat may be required, even though the mission may be primarily peaceful.[xlii] Climate change will likely play an indirect role in major, sustained operations as well. Poor economic conditions, fresh water resources, and lack of basic services to a population can compound regional conflicts, boarder disputes, and civil wars. Climate change can amplify these conditions by acting as a secondary driver.[xliii] Many of these conflicts, when elevated to warfare, may require US military involvement.

ROMO	Capability Demand
Military engagement, security cooperation, and deterrence	Moderate
Crisis response and limited contingency operations	Severe
Major operations and campaigns	Minor

Table 2: Demand for Marine Corps capabilities across the range of military operations.

The Republic of Yemen, A Case Study

> Water is and will be the reason for powerful conflicts in the future.
> - Abdulwali El Jilani, A water specialist with the US Agency for International Development funded Community Livelihood Project

The Republic of Yemen was created in 1990 after the unification of the Yemen Arab Republic (North Yemen) and the People's Democratic Republic of Yemen (South Yemen). Since the unification, the US has backed Yemen with aid and resources in order to promote economic, political, and security reforms.[xliv] The US also considers Yemen a valuable regional partner in

the fight against global terrorism, in particular against al Qaeda in the Arabian Peninsula (AQAP). Yemen is currently in the midst of both a chronic humanitarian crisis and a security crisis. Climate change is driving a decade long drought and according to the World Food Program, more than half of the country needs some form of humanitarian aid. Due to the current drought, millions are suffering from hunger, and half of the population does not have access to clean water.[xlv] Water scarcity alone does not increase the risk of civil war, but it does cause increased human suffering and contributes to instability.[xlvi] Yemen is already crippled with fewer resources than most regions around the world, and sustained violence would bring about shortages of food supply and production systems, damage to infrastructure and personal property, vectors for the spread of diseases, and strains on the limited available fresh water.

Yemen also faces a security crisis that is challenging its sovereignty and threatening to plunge the country back into civil war. On January 22, 2015, Yemeni President Abdu Rabu Mansour Hadi and his cabinet resigned from office after Houthi rebels launched attacks in Sana'a. Seizing control of the political vacuum, Houthi rebels disbanded the parliament and replaced it with a Houthi Revolutionary Committee on February 6, 2015. This committee will attempt to set up a 551-member National Transition Council to replace Yemen's parliament.[xlvii] As of February 11, 2015, the Department of State has closed the U.S. Embassy in Sana'a over security concerns in the country.[xlviii]

The Houthis forced their way into power seeking narrow political goals. They now inherit an impoverished Yemen, and the Houthis have neither the capability nor the capacity to control Yemen. The political reality is that the Houthi rebels do not have the needed economic or technical skills to run Yemen, especially with its poor economic conditions, lack of fresh water resources, and continued decline of basic services.[xlix] Often rebel groups finance a rebellion

through extorting natural resources.[l] Unfortunately, Yemen has very few and is soon to run out. In fact, positive oil revenues are expected to end by 2017, and the natural water supply could be exhausted by 2025.[li] The Houthi rebels will not have any resources to extort, thus hampering their ability to fund a sustained rebellion. Grievances from all sectors of Yemen, worsened by water scarcity, will continue to spread and the Houthis will not have the means to address them. As a consequence, the entire communities are at risk as well as the survivability of the state as it moves towards a renewed civil war.

The likelihood that the US military will be called upon to provide engagement, security cooperation, and deterrence operations in Yemen is moderate. Regional instability and conflict will only continue to rise as resources become strained. These conditions warrant the military's employment to support Yemen, intergovernmental organizations, or even non-governmental organizations to deter or mitigate the source of the conflict and to focus on common security goals.[lii] The demand for DoD to provide crisis response and limited contingency operations to Yemen is likely to be severe. Water scarcity that has been exacerbated by the drought has stressed already limited resources. Human suffering continues to mount and a Yemeni government, regardless of who is in charge, does not have the ability to respond. DoD can expect to be engaged to offset some of the suffering and perhaps mitigate the current conflict from escalating into a major operation or campaign.

A Case in point

Yemen's central government has been unable to provide effective security in large tracts of the country since the unification. And as the humanitarian crisis worsens, the government's capabilities continue to erode. As a result, terrorist groups have been able to exploit the situation.

Several individuals and terrorists groups with ties to Yemen have a history of attacks on the US and US interests in the region. Below is a list of some of the incidents:

- October 2000: The USS Cole was attacked while refueling in Aden, Yemen killing 17 US sailors and injuring 39.
- September 2001: Several of the 9/11 attackers had been trained and influenced by the American born Islamic militant Imam, Anwar al-Awlaki, operating out of Yemen.
- September 2008: Jihadi extremists attacked the US Embassy in Sana'a killing 12 local security forces.
- November 2009: US Army Major Nidal Malik Hasan killed 13 people at Fort Hood after communicating with Anwar al-Awlaki.
- December 2009: The "Underwear Bomber" who had lived in Yemen and was influenced by Anwar al-Awlaki attempted to detonate a bomb aboard a flight bound for the US.
- September 2012: Demonstrators stormed the US Embassy caused damage to the compound as part of the "Arab Spring."

The Marine Corps has been called upon to provide crisis response to Yemen in the last several years. After the latest incident during the Arab spring, the US sent a Fleet Anti-Terrorism Security Team (FAST) from the Marine Corps Security Forces to augment the existing Marine Corps Security Guard unit at the US Embassy. Then in 2014, the Marine Corps stood up a second Special Purpose Marine Air Ground Task Force Crisis Response (SP-MAGTF CR) for CENTCOM. Elements of this unit were sent to Yemen to further assist in the security efforts at the US Embassy.[liii] As the situation continued to deteriorate and the State Department closed the US Embassy in February 2015, these Marine units provided security as US personnel evacuated the country. This case shows that the demand for crisis response and limited contingency operations in a fragile country made worse by the effects of climate change will be severe.

Sound Adaptation Strategies

> The military doesn't have the luxury of playing politics with [climate change], with something that's actually happening, and you're seeing the effects already on the ground.
>
> - Andrew Holland, senior fellow at the American Security Project

To address the vulnerabilities associated with climate change, DoD should pursue adaptive policies that are broad enough to translate to other AORs. DoD should also implement policies that are both practical and opportunistic. Practical policies involve training and exercises that incorporate climate change conditions into the planning. Opportunistic policies provide wide reaching opportunities even if the future effects of climate change do not match the full scale of the worst-case predictions. Policies that incorporate all three attributes, provide the most effective adaptation strategies (see Figure 2)

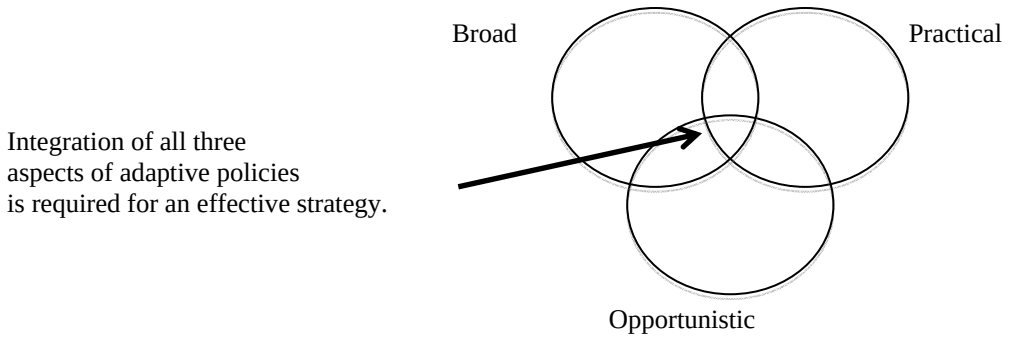

Figure 2: Integration of adaptive policy attributes construct.

The threats of climate change are as evident in USPACOM as in any other geographic component command within DoD. In a statement to the U.S. House Armed Services Committee, Admiral Samuel Locklear, Commander of USPACOM, acknowledges the security risk to his command. He states that, "typhoons, earthquakes, floods, tsunamis and cyclones are all too

common in Indo-Asia-Pacific. Increasingly severe weather patterns and rising sea levels threaten lives and property, and could even threaten the loss of entire low-lying nations."[liv] To address the potential impact, USPACOM has incorporated environmental strategy into its programs, including planning and exercises.[lv] This broad and practical approach allows PACOM to better prepare for the impacts of climate change and should be mirrored by other geographic component commands.

Climate change policies should also be opportunistic. U.S. political and military leaders still debate the causes of climate change and the effectiveness of mitigation efforts; however, most agree that weather is changing. Additionally, future climate change models extrapolate predictions and are inherently uncertain. Therefore, DoD should develop policies that provide wide reaching opportunities even if the future effects do not match the full scale of the worst-case predictions. Joshua Busby, an associate professor at the Lyndon B. Johnson School of Public Affairs at the University of Texas at Austin, calls these "no-regret" policies.[lvi] Busby argues that the sheer number of people living in vulnerable coastal regions where moderate storms have significant impacts justify these policies. DOD investment in foreign infrastructure improvements like evacuation routes could save lives in emergencies such as terrorist attacks that are not related to climate change. Additionally, military to military initiatives and exercises help strengthen partnerships that could be beneficial in future conflicts.[lvii]

Climate change also provides the Marine Corps the opportunity to train towards some of its core capabilities such as Non-combatant Evacuation Operations (NEO). NEOs assist the Department of State (DOS) by evacuating both U.S. and non-U.S. personnel during a crisis. Training for a NEO provides two benefits: first, DOD would be better prepared should an actual NEO be required due to a climate change or any other emergency. Second, DOD and DOS, and

potentially multiple U.S. agencies, would have a chance to coordinate and communicate, thus enhancing the interagency process. Dr. Daniel Chiu, Deputy Assistant Secretary of Defense for Strategy and Force Development, reiterated the importance of interagency collaboration by stating, "Understanding the complexities and uncertainties of climate change require a whole-of-government approach."[lviii]

Climate change is a global threat and partnerships with our allies are just as important as our internal agencies. Many countries are incorporating climate change strategies into their defense documents. Australia, for example, detailed in their 2013 White Paper the capabilities the Australian Defense Force (ADF) will need in the upcoming years. Pressure on global energy, food and water resources from climate change will be a major influence on ADF policy. The White Paper states, "The combination of the effects of climate change and resource pressures will increase the risk of insecurity and conflict, particularly internal instability in fragile states, many of which have increasingly large populations in areas that will be affected by climate change. These factors, taken together, point to an increasing demand for humanitarian assistance, disaster relief and stabilization operations over coming decades."[lix]

The United States mirrors the Australian approach in its own National Security Strategy (NSS) document. Released in February 2015, the NSS lists climate change as a significant threat to national security. The NSS states, "Climate change is an urgent and growing threat to our national security, contributing to increased natural disasters, refugee flows, and conflicts over basic resources like food and water."[lx] The US plans to address these threats through domestic mitigation efforts as well as international leadership through treaties and negotiations to reduce greenhouse gases. National emphasis on climate change drives funding, agency policies, and boosts the effort needed to combat this threat.

Conclusion

The world is currently experiencing impacts from climate change such as an increase in sever storms, sea level rise, and second order effects on human systems. Forecasting what and how severe those impacts will be in the future is more complex. Predictions are scientifically sound but are still based on models, studies, and estimates all the while trying to weigh the inherently unpredictable aspects of human behavior. Therefore, it is even more important to focus on adaptive strategies and planning when uncertainty is high to avoid forced mitigation efforts after the impacts are felt.

Climate change will severely increase the demand for some of the Marine Corps' core capabilities, particularly humanitarian assistance and disaster response missions. Additionally, climate change will drastically change the shape of the littorals, the Marine Corps' primary operating environment. Climate-related drivers such as higher sea levels, ocean acidity, and ocean temperatures will impact the physical structure of coastal systems. But physical drivers alone do not account for all of the predicted impacts due to climate change. Human systems stress the vulnerable littoral regions and compound the effects of climate change. As the population centers continue to grow on the coasts, resources become strained and more of the land becomes urbanized. As a result, the physical environment will be drastically altered and more of the population is at risk.[lxi] Understanding how the operating environment will change and what affect that change will have on future missions is the key to informing sound strategies and adapting to future climate change.

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