HOW SHOULD THE DEPARTMENT OF DEFENSE APPROACH ENVIRONMENTAL SECURITY IMPLICATIONS OF CLIMATE CHANGE

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

EMANUEL J. COHAN, MAJOR, USAF
B.A., Florida International University, Miami, Florida, 1995
M.S., California State University, Long Beach, California, 1998

Fort Leavenworth, Kansas
2009

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
11-12-2009	Master's Thesis	FEB 2009 – DEC 2009

4. TITLE AND SUBTITLE

How Should the Department of Defense Approach Environmental Security Implications of Climate Change

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Maj Emanuel J. Cohan

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

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

U.S. Army Command and General Staff College
ATTN: ATZL-SWD-GD
Fort Leavenworth, KS 66027-2301

8. PERFORMING ORG REPORT NUMBER

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

10. SPONSOR/MONITOR'S ACRONYM(S)

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

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for Public Release; Distribution is Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Environmental Security (ES) is a process for analyzing and responding to those environmental issues caused by anthropogenically driven environmental degradation. Climate change is a major ES threat having the potential to affect U.S. national security and thus has significant impact for the military national defense mission. This paper considers the most up-to-date climate change projections published by the IPCC, NASA, and the U.S. Global Change Program along with the latest national strategic guidance in order to determine actions required by the DoD. An overwhelming number of greenhouse models indicate considerable changes will affect U.S. national security during the mid 21st century. In addition, the study shows the DoD is currently at the onset of strategically organizing itself to analyze climate change impacts, provide combatant commanders with relevant mission preparedness information, and assess impacts to U.S. military installations of rising sea level/extreme weather events. Therefore, this study makes the following four recommendations: (1) ES must be a national security component, (2) DoD must establish an activity dedicated to develop ES related strategy, (3) Climate change data should be incorporated into a yearly Intelligence Environmental Estimate, (4) USJFCOM should take the lead in developing climate change related training scenarios.

15. SUBJECT TERMS

Environmental Security, Climate Change, Strategy, National Security, Intelligence, Homeland Security

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. PHONE NUMBER** *(include area code)*
(U)	(U)	(U)	(U)	79	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

MASTER OF MILITARY ART AND SCIENCE
THESIS APPROVAL PAGE

Name of Candidate: Maj Emanuel J. Cohan

Thesis Title: How Should the Department of Defense Approach Environmental Security Implications of Climate Change

Approved by:

_____, Thesis Committee Chair
W. Chris King, Ph.D.

_____, Member
Allan S. Boyce, M.S.

_____, Member
LTC Michael R. Anderson, M.S.

Accepted this 11th day of December 2009 by:

_____, Director, Graduate Degree Programs
Robert F. Baumann, Ph.D.

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

HOW SHOULD THE DEPARTMENT OF DEFENSE APPROACH ENVIRONMENTAL SECURITY IMPLICATIONS OF CLIMATE CHANGE, by Major Emanuel J. Cohan, 79 pages.

Environmental Security (ES) is a process for analyzing and responding to those environmental issues caused by anthropogenically driven environmental degradation. Climate change is a major ES threat having the potential to affect U.S. national security and thus has significant impact for the military national defense mission. This paper considers the most up-to-date climate change projections published by the IPCC, NASA, and the U.S. Global Change Program along with the latest national strategic guidance in order to determine actions required by the DoD. An overwhelming number of greenhouse models indicate considerable changes will affect U.S. national security during the mid 21st century. In addition, the study shows the DoD is currently at the onset of strategically organizing itself to analyze climate change impacts, provide combatant commanders with relevant mission preparedness information, and assess impacts to U.S. military installations of rising sea level/extreme weather events. Therefore, this study makes the following four recommendations: (1) ES must be a national security component, (2) DoD must establish an activity dedicated to develop ES related strategy, (3) Climate change data should be incorporated into a yearly Intelligence Environmental Estimate, (4) USJFCOM should take the lead in developing climate change related training scenarios.

ACKNOWLEDGMENTS

An academic undertaking of this scale would not have been possible without the insight and dedication of my thesis committee. Their efforts challenged my assumptions and provided the needed guidance to complete this work.

I would first like to thank my thesis committee. Dr. King as committee chair helped focus my efforts and keep me on track throughout this process. His knowledge on environmental science ensured this work considered the latest scientific and policy information available. LTC Anderson was instrumental in helping me communicate effectively and structuring my argument logically. Mr. Boyce challenged my assumptions and provided an essential objective perspective in reviewing my research. Their efforts were vital to this study.

Secondly, thanks are owed to Dr. Constance Lowe who provided me crucial guidance and wisdom and whose inquisitive questions helped me select this topic. Finally, I would like to thank Ms. Cary Garcia who painstakingly edited my first draft. It is my hope that this product is worthy of their efforts.

TABLE OF CONTENTS

Page

MASTER OF MILITARY ART AND SCIENCE THESIS APPROVAL PAGE iii

ABSTRACT iv

ACKNOWLEDGMENTS v

TABLE OF CONTENTS vi

ACRONYMS viii

ILLUSTRATIONS x

CHAPTER 1 INTRODUCTION 1

- Primary Research Question 3
- Secondary Research Questions 3
- Definitions 3
- Limitations 7
- Delimitations 7
- Assumptions 7
- Significance of the Study 8
- Background 9

CHAPTER 2 LITERATURE REVIEW 15

- Climate Change 17
- Water Resources and Changes in Precipitation 18
- Sea Level Rise and Ocean Acidification 20
- Meridional Overturning Circulation 22
- What Climate Change Does 23
- IPCC Fourth Assessment Report 25
- Global Climate Change Impacts in the United States 30
- Strategic Guidance 32
- The Obligation of the U.S. 39
- Summary 40

CHAPTER 3 ANALYTICAL RESEARCH METHODOLOGY 42

CHAPTER 4 ANALYSIS 45

- Secondary Research Questions 45
- Primary Research Question 53

CHAPTER 5 RECOMMENDATIONS.....64

Recommendations..... 64

REFERENCE LIST 65

INITIAL DISTRIBUTION LIST 69

ACRONYMS

COCOM	Combatant Command
DHS	Department of Homeland Security
DIME	Diplomatic, Informational, Military, and Economic
DoD	Department of Defense
DoS	Department of State
DSCA	Defense Support to Civil Authorities
FEMA	Federal Emergency Management Agency
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NIE	National Intelligence Estimate
NOAA	National Oceanic and Atmospheric Administration
OSD	Office of the Secretary of Defense
PPM	Parts Per Million
QDR	Quadrennial Defense Review
UN	United Nations
UNEP	United Nations Environmental Program
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USGCRP	United States Global Change Research Program
USNORTHCOM	United States Northern Command

USJFCOM	United States Joint Forces Command
USPACOM	United States Pacific Command

ILLUSTRATIONS

Page

Figure 1. Atmospheric CO_2 concentration measured at Mauna Lab Observatory.....6

Figure 2. Global Annual Mean Surface Air Temperature Change.....12

Figure 3. Comparison of Observed Continental and Global-Scale Changes in Surface Temperature.....27

Figure 4. Regional Distribution of GHG Emissions by Population and GDP. 30

Figure 5. Thesis Systematic Data Analysis.....44

Figure 6. Notional Organization of the Office of Environmental Security Strategy 57

CHAPTER 1

INTRODUCTION

For a better part of the 20th century, issues relating to the environment, climate change, and environmental degradation were seen as abstract concepts far-off in a distant land. Many scientists and scientific publications considered global warming caused by the release of greenhouse gases, predominately carbon dioxide, as a slow developing concern that can be addressed in the future. During the last quarter of the 20th century, improved science and analysis techniques resulted in an enhanced understanding of climate change that sparked fierce debate among scientists and policy makers on whether global warming was occurring and on its long-term effects. In addition, a growing community began to realize a need to consider climate-induced change in national security planning. General Maxwell Taylor, who in 1974 suggested creating "an expanded National Security Council charged with dealing with all forms of security threats, military and nonmilitary, and having access to all elements of government and to all relevant resources capable of contributing to this broad task" (Campbell 2008, 3). Further, over the past two decades the concept of climate-induced change; how it should affect U.S. environmental security policy has generated significant discussion, especially given the growing awareness resource scarcity driven by climate change will have on violence, civil strife and regional destabilization.

In 2007, the Intergovernmental Panel on Climate Change (IPCC) chartered under the United Nations Environmental Program issued their *Fourth Assessment Report on Climate Change*, providing the world with the most comprehensive and up-to-date scientific data on climate change. More recently, the U.S. Global Change Research

Program released a report titled *Global Climate Change Impacts in the United States.* This report focuses on the U.S. regional effects of climate change now and in the future. While this research does spend a considerable amount of time in review and analysis of climate-induced change, the purpose is to demonstrate how climate-induced change will affect the nation. Much of the work performed by the IPCC and USGCRP is referenced in this report to project future climate.

The goal of this study is to make strategic recommendations on the direction the Department of Defense (DoD) should take to address environmental security to properly posture the department and effectively plan for climate related change, while also providing relevant information to combatant commanders and service components so they can adequately prepare the force. Within the many operational centers and organizations in the DoD, the concept of environmental security lacks a commonly accepted definition. For the purpose of this research, environmental security is "a process for responding to those environmental issues having the potential to affect U.S. national security has significant implications for the military national defense mission" (King 2000, 14). This definition sets the threshold for all of the work that will follow in this study. More broadly, this research paper intends to serve national security needs by providing an understanding of current climate-induced threats and identify actions necessary to better act upon environmental security risks.

This thesis compiles much research performed on climate change, its outcomes and analysis. Chapter 2 provides a literature review on relevant climate change studies, national security strategy, and DoD publications. Chapter 3 describes the thesis methodologies and analysis process. Chapter 4 analyzes and summarizes the findings of

the literature review and applies security threat analysis to understanding the problem. Chapter 5 presents this paper's final conclusions.

Primary Research Question

How should the Department of Defense approach environmental security implications of climate change?

Secondary Research Questions

1. Does the Department of Defense have an environmental security direction?

2. What conditions of climate change are likely to provide security risks to the U.S. in the near term?

Definitions

Throughout this research, the term "Environmental Security" is used to describe a process for addressing climate induced environmental concerns that pose a threat to national security. Further, this paper uses the definition for environmental security as it is applied in this research:

> Environmental security is a process for effectively responding to changing environmental conditions that have a potential to reduce peace and stability in the world and thus affect U.S. national security. U.S. environmental security involves accomplishment of the environmentally related actions specified in the National Security Strategy. Accomplishing U.S. national environmental security goals requires planning and execution of programs to prevent and/or mitigate anthropogenically induced adverse changes in the environment and minimize the impacts of the range of environmental disasters that could occur. (King 2000, 17)

This research paper is based on the most up-to-date scientific data relating to climate change and makes use of the latest national strategic documentation. The purpose of this study is not necessarily to describe climate change itself, but how those changes

will refocus U.S. national security concerns. A cornerstone of the research paper is based on the United Nations IPCC research, specifically extracts from the *IPCC Forth Assessment Report,* which utilizes a scenario based approach to establish four plausible scenarios of future climate changes. The 2009 U.S. Global Change Research Program recently published report on Global Climate Change Impacts in the United States is utilized to demonstrate observed and expected climate change which poses national security threats. Throughout this research the author has taken a "middle of the road approach" in respect to selecting and presenting climate modeling data. Many of the contemporary (CY2006-09) climate models present ranges that vary from mild to catastrophic changes based mainly on the level of human use of fossil-based fuels such as oil and coal. Since there is a range of climate model results, this research paper uses the median (the middle value) result to illustrate future outcomes.

Within the content of this research paper several key terms are used, including:

Carbon Dioxide (CO_2). This gas is responsible for a majority of the human caused input of greenhouse gasses. Major sources include fossil-fuel burning and deforestation. CO_2 remains in the troposphere for approximately 500 years--20 percent lasts for a millennium.

Chlorofluorocarbons (CFCs). These gases are synthetic compounds used extensively for refrigeration and aerosol sprays. They have a dual effect of warming the atmosphere because they absorb thermal radiation and significantly reduce ozone. When released into the atmosphere they destroy ozone (O_3) by removing one "O" atom, thus turning the gas into O_2. CFCs remain in the atmosphere for 65 to 111 years, depending on

the type. The Montreal Protocol agreement of 1987 is resulting in a reduction of CFC production.

Methane (CH_4). This gas is produced by bacteria that decompose organic matter in oxygen-poor environments such as landfills, materials left after deforestation, the digestive tracts of billions of cattle, sheep, pigs, other livestock, and humans. CH_4 remains in the troposphere for approximately seven to ten years and each molecule is 26 times more effective in warming the atmosphere than a molecule of carbon dioxide.

Nitrous Oxide (N_2O). This gas is released by the breakdown of nitrogen fertilizers in soil, livestock waste, nitrate-contaminated groundwater, and by biomass burning. N_2O remains in the troposphere for an average of 150 years and each molecule is 200 times more effective in warming the atmosphere than a molecule of carbon dioxide.

Greenhouse effect. The greenhouse effect is the raising of air temperature that occurs when the lower atmosphere (troposphere) traps and contributes to the buildup of heat near the earth's surface. Water vapor, carbon dioxide, methane, and several other gases in the atmosphere absorb a portion of the long-wave energy flowing back towards space from the earth's surface and redirects the energy back towards the earth's surface.

Climate change. Any systematic change in the long-term statistics of climate elements such as temperature, precipitation, and wind sustained over several decades or longer. Climate change may be due to natural external forcing, such as changes in solar emission; natural internal process of the climate system; or anthropogenic forcing (American Meteorological Society 2009). Climate change and global warming are often used to describe the same effect.

Feedback effects. These are factors which can increase or decrease the rate of a process. For example, continued carbon dioxide loading through burning of fossil fuels can create a tipping-point where the northern tundra and underlying permafrost begin to melt, releasing tons of methane and carbon dioxide into the atmosphere. Carbon stored in the upper matter of permafrost is estimated at 700 billion metric tons. Feedback has a significant potential of creating a climate situation that will spiral out of control leaving humans little they can do to stop it.

Keeling Curve. A chart showing the variation in concentration of atmospheric carbon dioxide since 1958. It is based on continuous measurements taken at the Mauna Loa Observatory in Hawaii. Keeling's measurements showed the first significant evidence of rapidly increasing carbon dioxide levels in the atmosphere" (NOAA 2009). See figure 1.

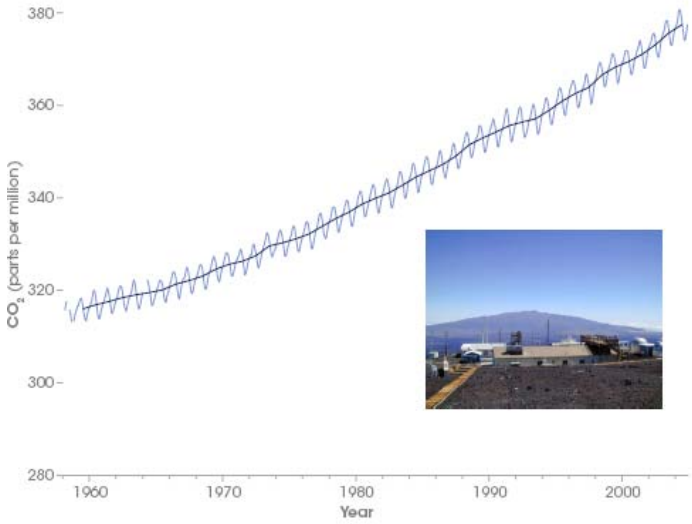

Figure 1. Atmospheric CO_2 concentration measured at Mauna Lab Observatory *Source:* NOAA, Keeling Curve. http://www.mlo.noaa.gov/home.html (accessed August 24, 2009).

Limitations

Information for this research is limited to unclassified open source information found in the US Army's Fort Leavenworth Combined Arms Research Library, international government organizations, U.S. Government generated data, civilian institutions, World Wide Web, open source databases, and the author's education on the subject matter.

Delimitations

Information on environmental security concerns caused by climate change has a profound potential to reduce peace and stability. Relevant information should be available to Combatant Commanders and DoD strategic planners so that there is an improved understanding of the strategic environment. Relevant information containing projected regional security concerns such as conflicts due to water/resource scarcity or mass population movements into neighboring countries that pose a challenge to U.S. national security are considered. This research, while not a paper on climate change, does introduce the reader to environmental science data to establish a basis of understanding in order to analyze observed and future climate related changes. The goal of this research is to illustrate near-term strategic challenges caused by climate change posing a significant threat to U.S. national security.

Assumptions

This paper makes three assumptions to establish a baseline for the research. First, issues relating to environmental security are not currently factored into strategic or service level organizations with enough specificity to provide Combatant Commanders

and Service Chiefs with relevant information to prepare the force. Second, intelligence gathering does not account for near and long-term climate induced changes that pose a threat to U.S. national security. A yearly-publicized document such as an intelligence environmental security estimate similar to that proposed by Secretary of State Warren Christopher could provide DoD and interagency decision makers with needed specificity to help anticipate future hotspots. Finally, it is likely the strategic structure to address environmental security within the U.S. Government including the DoD is virtually non-existent. A strategic structure or office can significantly contribute to an understand how decision makers can utilize available climate change data to adequately prepare the force, interagency, international community, and take advantage of synergistic effects realized from working in a combined team. The precedence set in many instances being the first to provide humanitarian/disaster aid along with its vast logistics capabilities, DoD with its expertise will play a lead role in climate related incidents by responding to disasters and civil unrest.

Significance of the Study

We are in a period where the window to take action to prevent climatic climate change is quickly narrowing. A growing number of estimates (Hansen 2008, 3) indicate we have less than a decade to take radical steps in order to significantly reduce the amount of greenhouse gases human activity release into the atmosphere. According to James Hansen, director of the NASA Goddard institute for space studies, “our home planet is dangerously near a tipping point at which human-made greenhouse gases reach a level where major climate changes can proceed mostly under their own momentum (Hansen 2008, 3). The Feedback effects James Hansen describes will cause

unprecedented warming, shift the hydrological cycle thus causing massive human migration in a scale never before seen.

There are two goals to this study. First, this study identifies the likely effects climate change will cause over the next thirty years. It discusses how climate-induced change will exacerbate drought conditions, heat waves, and rising sea levels. The point of discussing expected change is to explore the actions the DoD should be taking to prepare the force to anticipate and react to serious threats to the homeland and mankind. Operation Iraqi Freedom and Operation Enduring Freedom have allowed the services to change doctrine and tactics from those adopted to fight a monolithic enemy to fighting irregular warfare wars. Yet it has taken a number of years to adapt intelligence gathering, tactics, and acquisition of systems to better fight irregular warfare. Unfortunately, time has become the most precious commodity; DoD has just a few years to prepare for massive-scale disaster relief operations at home and abroad. A second goal of this research is to take a look at the DoD's current progress in building awareness in those climate related changes that pose a threat to U.S. national security. Consideration of strategic documentation to include the National Security Strategy, National Defense Strategy, and National Military Strategy along with applicable Service doctrine is researched.

Background

Human awareness of anthropogenic induced climate change is a relatively recent discovery and the science is now mature enough where climate change can be projected within a reasonable range of certainty. Until fairly recently humans were not fully aware of threats to the environment caused by anthropogenic activity. In fact, American

biologist Rachel Carson's seminal work *Silent Spring* released in 1962 was one of the first studies resulting in a book that identified food-chain poisoning caused by dichlorodiphenyl trichloroethane (DDT) used in pesticides and weed killer. Her book identified the effects of food-chain poisoning by tracing how DDT, once released into the environment makes its way through the food chain, killing or mutating vulnerable species. In another case, a small body of scientists, as early as the 1950s, hypothesized chlorofluorocarbons were likely depleting the ozone layer. NASA's Nimbus-7 satellite was the first satellite in 1980 to perform global ozone level measurements, thus proved their hypothesis correct by showing scientists ozone holes were indeed present at both polar ends and adjoining lands (NASA 2009). Chlorofluorocarbons (CFCs) are entirely man-made; they are used in refrigeration and as a propellant in aerosol cans were the main culprits. The Montreal Protocol of 1987 called for the phase-out of CFC by 2010; however, the lingering effects of the gas will continue to degrade ozone for many decades to come. Now, newer models of meteorological satellites are sending imagery of increasing global heat patterns along with the capability to identify areas of thinning ozone. With the ability for satellites to collect weather data along with globally networked ground and oceanic monitoring devices, scientists began clearing-up lingering discrepancies in climate change data.

By the 1990s the science used to predict the effects of anthropogenic and naturally occurring greenhouse gases and aerosols matured to the point where a growing body of scientists acknowledged change was occurring. Meteorological satellites capable of measuring water vapor, global ozone levels, and temperature variances gave scientists the raw data needed to model global warming trends and its consequences. Further, a

critical piece of data needed to reconstruct the planet's historical climate was locked deep in glacial ice sheets where air bubbles containing air and oxygen isotopes allowed scientists to recreate climate conditions present nearly a million years ago. In addition, during this period, the topic of environmental security began to gain traction in U.S. Government and DoD with the establishment of several key environmental security positions such as the National Security Council director for environmental affairs and the DoD's Deputy Undersecretary Defense for Environmental Security.

During the Clinton and George W. Bush administrations both presidents took the position the country was not going to be a signatory in the Kyoto Protocol. The Kyoto Protocol is an international agreement that sets binding targets for reducing greenhouse gas emissions. The U.S. is still the only major industrialized country refusing to implement provisions outlined in the Protocol. President Bush's "reservation echoed Clinton's--it might stall economic growth, and developing nations such as China and India were not required to comply--and cast a doubt on the scientific evidence that human activity drove climate change" (Campbell 2008, 10). As of February 2009, 183 states have signed and ratified the Kyoto Protocol. By not ratifying the Kyoto protocol the U.S. forfeited any ability to take a leadership role in developing climate change policy. Further, the U.S. sent a clear message to the world that as one of the largest (total and per-capita) contributor of greenhouse gases did not intend to alter its fossil fuel use. In retrospect, the US failed at an opportunity to lead the world out of the more serious effects of climate change that according to a growing body of scientific research is only a few decades away. In addition, as a leading per-capita greenhouse gases emitter, the U.S.

will likely be asked with increasing frequency to assist governments not capable of handling large-scale relief operations for themselves.

According to climatologists at the NASA Goddard Institute for Space Studies (GISS), "2007 tied with 1998 for the Earth's second warmest year in a century" (NASA, 2009). See figure 2.

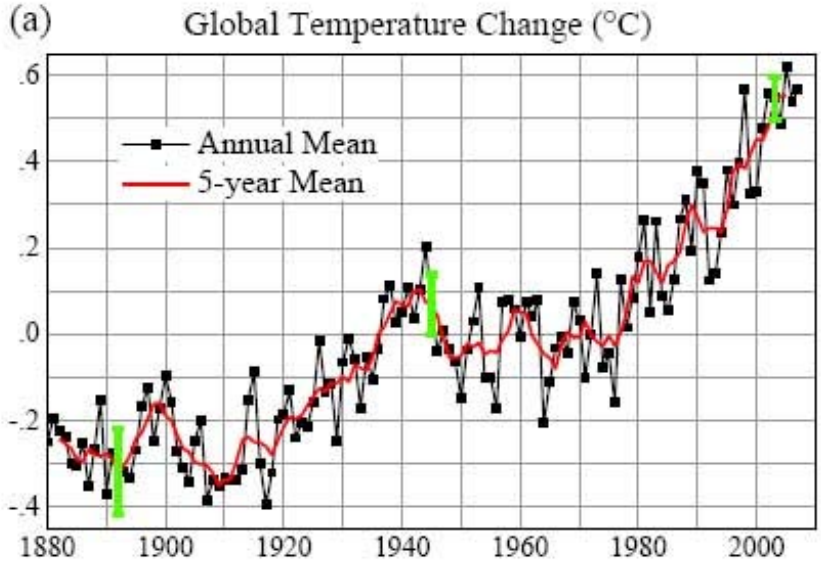

Figure 2. Global Annual Mean Surface Air Temperature Change
Source: NASA Goddard Institute for Space Studies. Datasets & Images. http://data.giss.nasa.gov/gistemp/graphs/ (accessed July 2, 2009).

In 2007 the IPCC released their *Fourth Assessment Report* (AR4), which was complied by thousands of authors from dozens of United Nations (UN) member countries. AR4 confirmed what many U.S. scientists suspected for several decades, "most of the observed increase in global average temperatures since the mid-20th century is

most likely due to the observed increase in anthropogenic greenhouse gas concentrations" (IPCC 2007f, 36).

It is evident with the Army's sponsorship of a conference on the *National Security Implications of Global Climate Change* and participation in the Center for Naval Analysis (CNA) conference on climate-induced challenges that the DoD in 2007 began to recognize that climate change has a significant potential to threaten national security. However, the lingering questions are how much warming will occur, how fast, and what areas will be affected? Surprisingly, the U.S. Government, almost two decades ago was better prepared to develop environmental security strategy than it is today. The DoD along with most U.S. Government agencies are in the process of determining how they will make institutional changes to better manage for climate change and develop an environmental security strategy. In March 2007, the U.S. Army War Collage sponsored a two-day conference on the topic "The National Security Implications of Global Climate Change." A major goal of the colloquium held in Chapel Hill, North Carolina was to provide insight to the consequences of climate change to military members, interagency, and academic researchers. General Weitz (Ret. USA) provided closing comments where he stated, 'it is now widely accepted that climate change can seriously threaten U.S. national security" (Pumphrey 2008, 408). In addition, on April 2007 the CNA issued a key report that received considerable press in the national security community because of its advisory board of retired senior general officers. General Zinni, one of CNA's climate change advisory board members speaking on issues relating the Middle East said, "you already have great tensions over water, it's not hard to make the connection between climate change and instability" (CNA 2007, 31).

Improvements in climatic science make it possible to predict with a high level of certainty the effects climate-induced change will have on earth. Models show which regions of the world will be impacted in the near future and demonstrate that the biggest security challenge confronting the U.S. is climate-induced change. Climate change is not an easy topic to understand and it is even harder to come up with mitigating factors to deal with the effects. The challenge now for the DoD is to act quickly at establishing an activity capable of analyzing all aspects of environmental security of climate change to properly prepare the force and provide policy makers with decision-making information that will lead to a comprehensive approach to national security implications resulting from climate change.

CHAPTER 2

LITERATURE REVIEW

The purpose of this research is to analyze existing open source U.S. Government documentation relating to climate change and national security. This chapter is divided into two broad topic areas that include climate science and strategic guidance which also include publications relating to climate change. Further, the paper reviews the latest available public accessible documentation, peer-reviewed research on national security impacts of global climate change. While many sources of information are used, the latest reports published by the Intergovernmental Panel on Climate Change (IPCC) assessments and the recently published *Global Climate Change Impacts in the United States*, by the U.S. Global Change Research Program were chosen because both research publications draw on a wide body of international, domestic, private and public sector experts. Both publications are cornerstone documents in this literature review. This chapter includes an introduction to climate change, impacts to the population from sea-level rise, ocean acidification, precipitation change, water availability, resource scarcity, national strategy, and other topics relevant to national security.

Climate change knowledge and disciplines such as meteorology and environmental science present humans with a relatively new understanding of how changes in climate will affect various regions around the globe. Looking back a few hundred years ago, recorded weather history in the U.S. dates back to the late 1700's when weather data was collected by Army Surgeons, Smithsonian observers, and the Naval Observatory until the mid 1800s (Grice 2005). In late 1870s the Army Signal Service began recording weather observations in Washington, D.C. until the U.S.

Weather Bureau was established in 1891 as the office charged with observing and recording weather. The science of meteorology is also a recent practice dating back to 1861 when Francis Galton in his book *Meteorgraphica* displayed weather charts showing areas of similar air pressure and interpreted weather data. In 1875, Galton published the first weather map in a London newspaper displaying regions of high and low pressure that forecasted weather conditions. Many of the meteorological methods established by Galton are still in use today to forecast the weather.

Until 1960, meteorologists relied on a network of over 1200 terrestrial climate-monitoring stations, aerial weather balloons, buoys, and weather reconnaissance aircrafts to make observations and forecast weather events. During this period, most weather stations were not networked and there were few timely systems in-place to give scientists and meteorologist a comprehensive global awareness of changing weather patterns. On April 1, 1960 NASA launched the world's first weather satellite. The Television Infrared Observation Satellite (TIROS-1) was a polar orbiting craft that sent thousands of images back to the ground station at Fort Monmouth, New Jersey (Alfred 2008). As recently as July 15, 2004, NASA launched Aura; dedicated to giving scientists greater ability to monitor complex interactions such as global ozone levels, ocean temperatures and polar ice melt trends.

Much of climate related science is new and there remains skeptics who challenge the accuracy of historical weather observation data. However, scientists do have 800,000 years of recorded carbon dioxide concentration data trapped in Antarctic ice core extractions. Like a buried time-capsule, the trapped air bubbles along with sediment deposits allows scientists to chart carbon dioxide levels which closely correlates to

historical global temperatures. Another important discovery occurred in the mid-1950s when chemist Charles Keeling began taking air samples across the U.S. with the purpose of analyzing the amount of carbon dioxide gas present in his air samples. In his lab at the California Institute of Technology, he conducted precise measurements and discovered the level of carbon dioxide was nearly the same at every location sampled--310 to 315 parts per million (ppm). In 1958, Keeling began graphing levels of carbon dioxide taken at the Mauna Loa Observatory in Hawaii. The graph (figure 1), or Keeling Curve, helps anchor the debate about climate change in undisputable facts. As of August 2009, carbon dioxide measurements at the Mauna Loa Observatory registered at 385ppm--an increase of approximately 73ppm in half a century.

Climate Change

What is climate change? Simply stated, it refers to "any change over time, whether due to natural variability or as a result of human activity (IPCC 2007e, 26). This condition results in long-term, unbalanced weather cycles and sifts in hydrological patterns--ultimately leading to profound scarcity of resources. Scientists have known for over a hundred years that adding significant quantities of carbon dioxide to the atmosphere raises the planet's temperature. This basic principle is known as the greenhouse effect and is caused by greenhouse gases, predominately carbon dioxide, but also chlorofluorocarbons, methane, nitrous oxides and an increase in water vapor. Scientists have also determined there is a correlation, between global temperatures and the level of carbon dioxide. In fact, 11 of the 12 warmest years on record have occurred since 1995 (NOAA 2009). Further, the authors of the recently released study from the

U.S. Global Change Research Program attribute much of the warming due to burning fossil fuels. Below is an excerpt of their findings:

> Observations show that warming of the climate is unequivocal. The global warming observed over the past 50 years is due primarily to human-induced emissions of heat-trapping gases. These emissions come mainly from the burning of fossil fuels (coal, oil, and gas), with important contributions from the clearing of forests, agricultural practices, and other activities. (USGCRP 2009, 13)

According to John Houghton in his book titled *Global Warming*, he attributes the main driver of climate change is human activity related to deforestation, transportation and in particular those activities that release carbon dioxide into the atmosphere. An increase in carbon dioxide acts like a blanket over the earth, keeping it warmer than it would otherwise be. As temperatures increase, so does the amount of evaporated water vapor in the atmosphere which causes a greater blanketing effect, thus causing temperatures to remain higher (Houghton 2004). One of the problems with the casual observation of climate change is that it is not obviously noticed because it is disguised by day-to-day weather fluctuations. To the casual observer it may seem that events such as heat waves, drought and more intense storms are anomalies. The fact is, in the decades to come climate-induced changes are expected to continue and will profoundly affect human health, water availability and agriculture.

Water Resources and Changes in Precipitation

A great deal of information is available on the topics of water resources and the changing cycles of precipitation. Lester Brown's *Plan B 3.0* discuses how several regions around the world are in a state of "soaring demand for irrigation water coupled with declining rainfall" replenishing lakes and aquifers. According to Brown, water demand has tripled over the last half-century and demand for hydroelectric power has grown even

faster (Brown 2008, 75). Already, water reservoirs around the planet are rapidly disappearing. Africa's Lake Chad bordered by Cameroon, Chad, Niger and Nigeria has receded to less than 20 percent of its former volume (BBC 2006). Global warming coupled with an unsustainable rate of water extraction required to provide drinking water and irrigation for the population surrounding Lake Chad is compounding the problem. In another example, the Jordan River, once a mighty river, provides much of the water used in Israel and Palestine. It is now a trickling stream during the summer months. Rapid population growth and drier summer months are contributing to decreased water availability. Water scarcity caused by climate change and higher than sustainable demand will be among the early climate related conflicts to take place in the 21st century. According to Brown, climate change is now affecting water supplies mainly because rising temperatures are increasing evaporation rates and altering earth's hydrological cycle. In a famous quote, Boutros Boutros-Ghali said: The next war in the Middle East will be fought over water and not politics."

As climate change progresses, warming will shift hydrologic cycles, affecting freshwater availability, reducing crop yields, ultimately leading to a scarcity of resources. Findings presented in *State of the World 2009*, indicate agriculture in the tropics, which are predominantly poor developing African countries are projected to be adversely affected even at low levels of warming. These findings are in agreement with those identified in the 2009 *Global Climate Change Impacts in the United States*, which point to prolonged drought periods in lower latitudes. Early evidence of climate change is being observed in many areas around the globe where water scarcity is quickly becoming a concern. Because water is intertwined with agriculture, water scarcity will also have a

direct impact on food production. In addition, climate change along with higher population levels, are stressing aquifers, lakes, and rivers around the globe. According to findings published by the U.S. Global Change Research Program, changes in precipitation are consistent with the warming observed over the past several decades. The U.S. is already beginning to experience changing patterns and intensity in precipitation. This is because warmer global temperatures contribute to a greater rate of evaporation resulting in increased atmospheric water vapor. Increased atmospheric water vapor, along with the need to redistribute heat, is contributing to changes in atmospheric circulation that tend to move storm tracks northward resulting in dry areas becoming drier and wet areas wetter (USGCRP 2009, 42). In addition, several reports on the topic point to changes in precipitation will continue to become more regionally concentrated as global temperatures rise and will be more intense with longer periods between rainfalls that will lead to increases in drought and desertification. When rain does occur, the intensity will cause flooding, leading to soil saturation and runoff. In the U.S. alone, the combination of longer dry periods and heaver rain conditions will significantly reduce existing crop yields, shift northward in growing zones, and decrease fresh water supplies.

Sea Level Rise and Ocean Acidification

During the twentieth century, recorded data show that the average sea-level rose by between 10 and 20 cm (Church 2006). The largest contribution during this period was from thermal expansion of ocean water; as oceans warm the water expands which in-turn cause sea-levels to rise (Houghton 2005). Melting of glaciers is another significant contributor to sea-level rise. Rising sea-levels have a significant potential of displacing tens of millions of people in the Caribbean, Pacific islands and along the U.S. coasts

predominately the Atlantic which in some areas have experienced over eight inches of observed sea-level rise in the last fifty years. “Coastal water temperatures have also risen by about 2 degrees Fahrenheit in several regions, and the geographic distributions of marine species have shifted (USGCRP 2009, 149). According to the Intergovernmental Panel on Climate Change (IPCC) baseline global greenhouse emission model show sea level rise is “expected to exacerbate inundation, storm surge, erosion and other costal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities” (IPCC 2007b, 15). Currently, models used to predict sea-level rise provide a moderate level of accuracy mainly because many factors such as the amount of deglaciation of Greenland and West Antarctic ice sheets, feedback, and amount of heat the oceans can store before significant thermal expansion occurs, presents a large range of variables. For example, the IPCC Special Report on Emissions Scenarios (SRES) predicts a range of sea-level rise between 13 and 20 feet over the next few centuries (IPCC 2007d, 17). The amount of sea-level rise mainly correlates with continued greenhouse gas emission at or above current rates, which will accelerate climate change, causing acceleration in sea level rise. During this century, models show the potential of a 6.6 to 9.8 feet sea level rise towards the end of the 21st century (Campbell 2008, 160). In addition, by “mid century, climate change is expected to reduce water resources in many small islands, for example in the Caribbean and Pacific, to the point where they become insufficient to meet demand during low-rainfall periods (IPCC 2007b, 16). Rising sea levels caused by climate change has the significant potential of displacing approximately a third of Americans who live in areas immediately bordering

the coasts (Crowell 2007, 23) and populations of the Pacific and Caribbean islands. Together, these populations total more than 40 million people (USGCRP 2009, 145).

Equally as serious as sea-level rise is ocean acidification. Of the total amount of human generated greenhouse gases, approximately half is absorbed by the oceans, making them more acidic. Higher levels of absorbed carbon dioxide cause carbonic acid to form contributing to a decrease in ocean pH level by 0.1 unit. A decrease in pH produces an increase in acidity while an increase in pH produces an increase in alkalinity. This situation has made the oceans more acidic than pre-industrial times (State of the World 2009, 69) (pH is a numeric value that indicates the relative acidity or alkalinity of a substance on a scale of 0 to 14. Since pH is a logarithmic scale, a decrease of 0.1 unit is an approximate increase of 30 percent more acid) (Kleypas 2005). An increase in acidity has a direct impact on thousands of marine species that depend on calcium carbonate to build shells and skeletons, thus decreasing the ability of marine species such as corals, crabs and lobsters to use available calcium carbonate, to survive. A lower pH level also has a diminishing effect on tiny plankton organisms which serve as the base of marine food chains. Lower yields of crab and fish is already being detected at the base of food chains off Alaska and in the North Atlantic (State of the World 2009, 69).

Meridional Overturning Circulation

According to IPCC models, it is very likely that the slowing of the Meridional Overturning Circulation (MOC) will occur during this century. The MOC moves warm upper waters into northern latitudes via the Gulf Stream and returns colder waters deep across the equator. The MOC is also responsible for moving heat across the Atlantic Ocean contributing to the moderate climate of maritime and continental Europe.

Introducing high quantities of fresh water from polar ice melt or shifts in planet heat distribution can disrupt or slow the MOC, resulting in changes to "marine ecosystem productivity, fisheries, ocean carbon dioxide uptake, oceanic oxygen concentration and terrestrial vegetation" (IPCC 2007b, 17). In general, modeling shows that MOC changes will contribute to an increase of warming in select global regions because redistribution of surface heat into deep oceans will diminish. Changes to the MOC will cause global precipitation patterns to decrease in certain areas, with changes more noticeable in "North Africa, the Middle East, Central America, the Caribbean, and northeast South America, including Amazonia" (Campbell 2008, 79). Climate models show increased precipitation will occur in the "eastern U.S., Canada, East Africa, northern eastern Asia, and southeast Asia" (Campbell 2008, 79). Finally, a MOC disruption, slowing, or collapse will contribute to an increase in sea-level in the north Atlantic region. The amount of sea-level increase is tied to the percentage of the MOC's capability to transport heat. For example, a slowing of 10 percent may have an effect of a few inches of sea level rise, while a MOC slowing of 60 percent or greater may contribute up to three feet of sea level rise in the north Atlantic. Several IPCC climate scenarios indicate it is unlikely that the MOC will "undergo a large abrupt transition during the twenty-first century" (IPCC 2007b, 17). Modeling in this area is still evolving and it is likely climate scientists will be able to develop MOC models which provide tighter timelines and impacts in the near future.

What Climate Change Does

Climate change will increase the acreage of heat-stressed forests, which are quickly becoming vulnerable to pest infestation such as the pine beetle epidemic in the Rocky mountain region. According to a top U.S. Forest officials, "The pine beetle

epidemic chewing through forests in Wyoming and Colorado could endanger roads, power lines and other infrastructure as millions of acres of trees fall to the ground" (Joyce 2009). Further, higher temperatures and a growing population is projected to increase water demands over most of the U.S., leading to a dramatic decrease in water supplies especially in west and southeastern regions of the country. The countries' population carrying capacity will significantly decrease.

In his *Tipping Point* paper, Dr. James Hansen, director of the National Aeronautics and Space Administration (NASA) Goddard Institute for Space Studies warns of a potential climate change tipping point where greenhouse gases reach a level where major climate changes occur under their own momentum. According to Hansen, at the current rate of greenhouse gas emissions, a tipping point where the earth's climate goes into a fast feedback where changes occur quickly in response to temperature change can happen in two to three decades (Hansen 2009, 13). One example of feedback cited by Hansen and other scientists is the thawing of huge quantities of organic material locked in frozen tundra such as in northern Canada or northern Russia, which has the potential of releasing billions of metric tons of methane into the atmosphere. Molecule for molecule, methane traps 26 times more heat than carbon dioxide and is persistent for a much longer period of time. How far are we from reaching a tipping point? A wide and growing body of scientists from the IPCC and NASA believe we are at the threshold of entering a climate change feedback cycle where change will begin feeding on itself and there would be little humans could do to stop runaway climate change from occurring. There appears to be growing consensus that reaching 450ppm carbon dioxide is the maximum allowable carbon dioxide level before a runaway climate change feedback begins to occur. As of

August 2009, atmospheric carbon dioxide levels were recorded at 385ppm--two years ago, carbon dioxide levels were recorded at 381ppm. At current global greenhouse gases emission trend, we will reach a climate change tipping point where runaway feedback will occur by the year 2050. Yet there are signs the planet is already heading to a tipping point and the threshold of 450ppm may actually be lower, causing runaway climate change to come sooner than projected. James Hanson has written extensively on this topic, here's a quote from a recent writing:

> The warming that has already occurred, the positive feedbacks that have been set in motion, and the additional warming in the pipeline together have brought us to the precipice of a planetary tipping point. We are at the tipping point because the climate state includes large, ready positive feedbacks provided by the Arctic sea ice, the West Antarctic ice sheet, and much of Greenland's ice. Little additional forcing is needed to trigger these feedback and magnify global warming. If we go over the edge, we will transition to an environment far outside the range that has been experienced by humanity, and there will be no return within any foreseeable future generation. (Hansen 2008, 4)

IPCC Fourth Assessment Report

A literature review on climate change impacts to national security would not be complete without covering the landmark IPCC *Fourth Assessment Report* (AR4) released to the public in February 2007. The organization's AR4 builds on the 2001 released *Third Assessment Report* and benefits from improved science, observation techniques and a more mature team organization. Al Gore used much of the data from AR4 in his book and the documentary movie on climate change *An Inconvenient Truth*. In December 2007, both the IPCC and Al Gore were awarded the Nobel Peace Prize "for their efforts to build and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change"(Nobel Foundation, 2007).

The AR4 is based on observed climate change and develops a series of models to illustrate trending levels of greenhouse gases emissions that will impact global climate change. The IPCC is the United Nations' leading body for the assessment of climate change; composed of more than 800 contributing authors, 2,500 scientific experts from 130 countries. In their report, the IPCC concluded that human activity has increased global atmospheric concentrations of greenhouse gases and concludes that "warming of the climate system is unequivocal." Several climatologists and authors believe IPCC's findings may be too conservative and do not reflect the true severity of the problem. For example, James Hansen believes we may have a decade or two before we reach a tipping point of where climate change begins feeding on itself, while IPCC general findings tend to place severe climate change towards mid 21st century. A review of IPCC's administrative function points to the fact that the organization does tend to be a conservative body, which can only make a statement by unanimous consent of all the scientific representatives of the world's participating governments.

In order to produce AR4, the IPCC divided the team into three Working Groups and a Synthesis Report group tasked to develop the IPCC report released to the public and policy makers. Working Group-1 published the Physical Science Basis report, Working Group-2 published Impacts, Adaptations and Vulnerability report, Working Group-3 published Mitigations of Climate Change report, and the Synthesis Group published the Summary for Policymakers.

The Physical Science Basis report builds on IPCC *Third Assessment Report* findings by using improved modeling techniques and a wider range of observable data. Vast improvements in computing power coupled with a better understanding of

environmental and climate science allowed for greater sophisticated analysis of data and extensive exploration of environmental uncertainty ranges. Figure 3 is a product from AR4 that displays a comparison of global and continental temperature change in surface temperatures with results simulated by climate models using natural and anthropogenic forcing (IPCC 2007d, 11). This shows that the models do replicate the historical records over the period of large-scale carbon dioxide increases and that natural causes do not account for the increase of temperatures for this period.

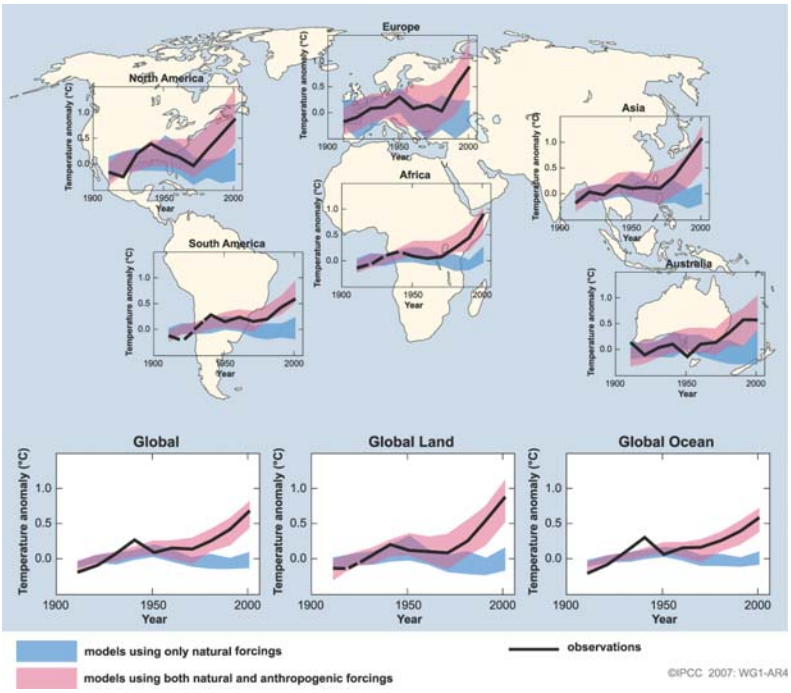

Figure 3. Comparison of Observed Continental and Global-Scale Changes in Surface Temperature

Source: IPCC, Synthesis Report, *Climate Change 2007*, Contribution of Synthesis Working Group to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (New York: Cambridge University Press, 2007), 40.

The *Impacts, Adaptations and Vulnerability* report builds on the findings of WG-2 along with a larger amount of evidence that has accumulated between CY 2002-2007 to project future environmental changes based on climate change trends. Further, the report's purpose is to assess studies of observed changes related to recent regional climate change. Several of WG-2 findings show that at current emission levels, recent climate change and climate variations such as sea-level rise, melting glaciers, flooding, drought, wildfires, growing insect populations, and ocean acidification will have an unprecedented effect on people and the environment this century. The "magnitude and timing of impacts will vary with the amount and timing of climate change" and, in some cases the capacity for ecosystems to adapt will likely be exceeded (IPCC 2007b, 11). Further, the *Impacts, Adaptations and Vulnerability* report provides specific information across the regions of the world on the nature and future impacts of climate change. Following is a limited summary of expected climate changes in North America through the 21st century:

1. The vulnerability of North America depends on the effectiveness and timing of adaptation and distribution of coping capacity. Adapting infrastructure to cope with altered water levels and achieving exiting water quality goals will be difficult and expensive (IPCC 2007a, 629).

2. Sea-level is rising along much of the coast, and the rate of change will increase in the future, exacerbating the impacts of progressive inundation, storm-surge flooding and shoreline erosion. Impacts on coastal communities and ecosystems will become more severe (IPCC 2007a, 619).

3. Climate change will further constrain North America's over-allocated water resources, increasing competition among agricultural, municipal, industrial and ecological uses. (IPCC 2007a, 619)

4. Climate trends and modeling indicate that by "the 2010 to 2039 time slice, year-round temperatures across North America will be outside the range of present-day natural variability." Areas that currently experience heat waves are expected to experience an increase in intensity and duration of these events (IPCC 2007a, 626).

5. Disturbances such as, wildfire and insect outbreaks as well as the incidence of infectious diseases are increasing and are likely to intensify in the warmer future. Further, the report observes a rapidly growing trend in forested areas burned in the western U.S. From 1987 to 2003 forest fires have burned 6.7 times the area burned from 1970 to 1986 (IPCC 2007a, 623).

The *Mitigations of Climate Change* report published by WG-3 concentrates on the scientific, technological, environmental, economic, and social aspects of mitigating climate change. This report introduces four (A1, A2, B1, B2) plausible emissions, economic and population based scenarios groups while introducing policy considerations that can be adopted in order to maintain a modern standard of living in tandem with controlling greenhouse gasses released into the atmosphere. The report takes a multifaceted approach of industrial and lifestyle change along with implementation of the latest efficiency technology and strong governmental regulatory policies to control emission of greenhouse gases.

Finally, the *Synthesis Report* is grounded in research and assessments developed by the three working groups. It provides an integrated and comprehensive summary of

the scientific, economic and technical studies presented in the three reports. While the Synthesis Report does not present new findings, it provides the reader with upfront facts without the voluminous references provided in the three working group reports. The figure below shows the distribution of regional per capita greenhouse gases emission. The U.S., with one of the smaller populations, is among the leading countries emitting greenhouse gases.

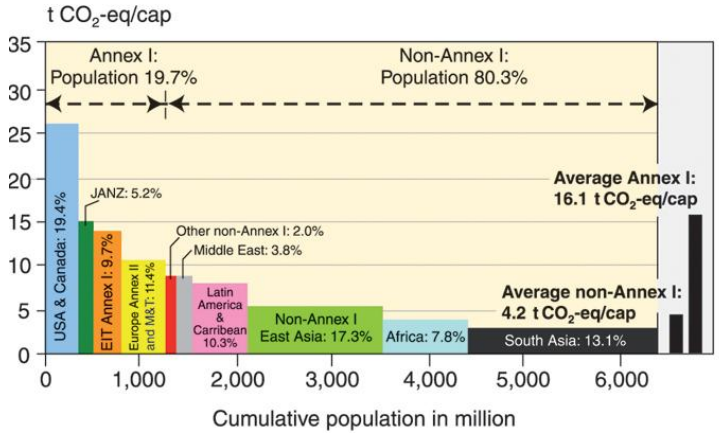

Figure 4. Regional Distribution of GHG Emissions by Population and GDP. *Source*: IPCC, Synthesis Report, *Climate Change 2007,* Contribution of Synthesis Working Group to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (New York: Cambridge University Press, 2007), 37.

Global Climate Change Impacts in the United States

In 2009, the U.S. Global Change Research Program published their findings and projections in their *Global Climate Change Impacts in the United States* report. The purpose of the report is to use recent scientific climate change data along with observed trends to determine how the U.S. will be impacted. In its opening executive summary, the

authors point to the fact, “Observations show that warming of the climate is unequivocal” (USGCRP 2009, 9).

One significant finding in the report is conclusive data that shows U.S. average temperature have risen more than 2 degrees Fahrenheit over the past 50 years (USGCRP 2009, 28). To help determine impacts of future temperature increase, the study team developed two greenhouse gases emission scenarios, partly based on the IPCC Special Report on Emissions Scenarios (SRES) B1 (lower emissions (LES)) and A2 (Higher emissions (HES)). The HES is based on current global output of greenhouse gases. Under the HES, projected temperatures will average 7 degrees Fahrenheit by mid century (2040-2060) and 11 degrees Fahrenheit by end-of-century (2080-2099) (USGCRP 2009, 29). Even under a concerted global effort to reduce greenhouse gases, data shows that under LES, projected temperatures will average 5 degrees Fahrenheit by mid century (2040-2060) and 7 degrees Fahrenheit by end-of-century (2080-2099) (USGCRP 2009, 29). By 2025 a combination of population increase and higher temperatures caused by climate change will lead to water supply conflicts in the west and southeastern U.S. (USGCRP 2009, 48). Moreover, in the near-term, increasing temperatures will accelerate forest fires in the west requiring military assistance in the form manpower and aerial assets. The report by the U.S. Global Change Research Program on *Global Climate Change Impacts in the United States* is considered the most up-to-date and authoritative document on climate impacts in the U.S. While the report bases estimates on IPCC AR4, it combines this data with recent information from 13 U.S. Government science, policy, energy agencies and 21 scientific groups to include US universities, the private sector and representatives from Canada. The report’s ten key findings are:

1. Global warming is unequivocal and primarily human-induced.

2. Climate changes are underway in the U.S. and are projected to grow.

3. Widespread climate-related impacts are occurring now and are expected to increase.

4. Climate change will stress water resources.

5. Crops and livestock will be increasingly challenged.

6. Coastal areas are at increasing risk from sea-level rise and storm surge.

7. Risk to human health will increase.

8. Climate change will interact with many social and environmental stresses.

9. Thresholds will be crossed, leading to large changes in ecosystems.

10. Future climate change and its impacts depend on choices made today.

Strategic Guidance

Given IPCC observed trends and the current knowledge on future impact, climate change is rapidly becoming a matter of national security. Projected effects of climate change pose a dangerous threat to U.S. national security and life, as we know it. Disappointly, today the DoD and U.S. government is less prepared to collect and analyze data relating to climate change trends that threaten national security than it was almost two decades ago. By contrast, in the early 1990s the DoD and several key government agencies had dedicated personnel to analyze climate change threats. For example, the National Security Council had a director for environmental affairs and the DoD had a deputy undersecretary defense for environmental security--both positions were eliminated. As of this writing, the DoD does not appear to have a strategic framework in place to analyze potential climate change related threats to national security.

Prior to SECDEF releasing the *2008 National Defense Strategy*, much of the available national strategy reveals a mixed trend in giving environmental security significant consideration. Starting with policy set by the executive branch, the *U.S. National Security Strategy* (*NSS*) is a document prepared periodically by the executive branch, which outlines major security concerns and serves as a guide for all areas of national government to align their internal strategic direction with those of the President's vision. One of the important national interests identified in the December 1999 *NSS* is "protecting the global environment from severe harm" (NSS 1999, 1). Six years later, the March 2006 *NSS* signed by President George W. Bush again makes mention of climate related events. Chapter 6 states that the U.S. has "joined with Australia, Japan, and the ROK in forming the Asia-Pacific partnership for clean development and climate to accelerate development of clean technologies to enhance energy security, reduce poverty, and reduce pollution." Further, the 2006 *NSS* in chapter 10 begins to acknowledge environmental destruction caused by human behavior and cites the environment as an opportunity to engage the global community. Between 1999 and 2006 the environment, along with climate change impacts to national security, took a back seat to more pressing issues such as combating terrorism, the Bush doctrine of preemptive war, Operation Enduring Freedom in Afghanistan, and Operation Iraqi Freedom.

The *National Military Strategy* (*NMS*), which is derived from the *NSS*, addresses the application of military power to help attain national objectives. The Joint Chiefs of Staff in consultation with Unified Combatant Commands, and the Office of the Secretary of Defense produce the document; final release authority is the Chairman of the Joint Chiefs of Staff (CJCS). The Chairman determines when to revise the *NMS*. The 2004

NMS released by CJCS General Richard B. Myers makes no mention of environmental security relating to climate change. The same is true for the *National Military Strategic Plan for the War on Terrorism* released 1 February 2006 by CJCS Gen Peter Pace, which mainly focuses on threats posed by terrorism, weapons of mass destruction, and other asymmetric threats.

Looking at the science and policy writings relating to climate change and national security reviles that the periods between the 1990s and halfway through the first decade of the twenty-first century have several vicissitudes in respect to administrative positions taken on climate change science. In addition, that period shows a mixed trend in the importance policy makers were willing to take action on reducing greenhouse gases. Part of the reason for the discrepancy is because climate change is going to affect different nations to different degrees, however, in the end will affect every nation. Furthermore, "special interests have undue sway with our governments and have effectively promoted minimalist actions and growth in fossil fuels, rather than making the scale of investment necessary" (Hansen 2008, 13).

As with all subject matters, there are the contrarians or skeptics such as Dr. Richard S. Lindzen, a professor of meteorology at the Massachusetts Institute of Technology who has been a critic of several global warming theories. In his May 2001 testimony to the U.S. Senate Commerce Committee, Dr. Lindzen told Senator McCain and other members regarding climate science that, "much of what informed scientists agree upon is barely quantitative at all" and "that man, like the butterfly, has some impact on climate" (john-daly). He further told the committee that the "IPCC was created to support the negotiations concerning carbon dioxide reductions" (john-daly).

While the 1990s through late 2005 may have been the period of uncertainty concerning climate change, 2007 was the year of awakening. A number of events and information helped solidify climate change is occurring and it is mostly due to the burning of fossil fuels and it poses a profound threat to national security. Much of the literature published after 2006 on climate change and threats to national security demonstrate a significantly improved understanding of climate science and the implications continued trend of greenhouse gases will result in. In 2007, Senators Richard J. Durbin (D-IL) and Chuck Hagel (R-NE) introduced a bill requesting a National Intelligence Estimate produced by the Central Intelligence Agency and the Pentagon to assess national security implications of climate change (Busby 2007, 1). Also in 2007, NASA's Goddard Institute for Space Studies announced global average surface temperature in 2007 tied those of 1998 as the warmest instrumental recorded year dating back to 1880. According to NASA, the record for the warmest recorded year is 2005, which also brought Hurricane Katrina, one of the five most costly and deadliest in U.S. history. Hurricane Katrina devastated Mississippi costal cities of Pascagoula where one the U.S. Navy's main shipyard is located costing over 1 billion dollars to restore and Biloxi, where Keesler AFB saw water levels rise six feet in a few locations. The Air Force spent hundreds of million to restore the base's operational capability. Hurricane Katrina however, is best known for the major damage caused by several breaks in the city's intricate levy system. In some ways, Hurricane Katrina gave the U.S. Government a small glimpse into what future impacts from climate change will look like. For the DoD, Hurricane Katrina should have raised the question of how the Department will select future placement of key infrastructure. The *Quadrennial Defense Review* (*QDR*),

along with the Base Realignment and Closure process are good policy documents to administer execution. In respect to climate change, the department does not have a long-term vision document such as the JCS *Joint Vision 2020* to help the Department forecast climate change trends, especially those that threat infrastructure.

In third place, for the warmest recorded year is 2003 which brought about many strange weather occurrences, including a blistering heat wave that swept across much of Europe, resulting in a French death toll of 14,802 and an overall European death toll of over 19,000 (*USA Today* 2003).

In late March 2007, the U.S. Army War College sponsored a multiday conference at the Triangle Institute for Security Studies on the topic of National Security Implications of Global Change. The main purpose of the conference was to consider how climate change would create new implications for national security and policy (Pumphrey 2007, 4). Participants included professors, research fellows, government representatives, active-duty and retired military officers who presented on a wide range of topics touching on the consequence of climate change, threats and concerns for the U.S. national security. Among topics discussed was the military's role in environmental security and disaster prevention, response and recovery. Several presenters touched on this topic noting how it is becoming an acceptable military mission and an essential element of regional stability (Pumphrey 2007, 9). A review of the U.S. Army Operations doctrinal publication introduces the operational environment and discusses how climate change and natural disasters will compound already difficult conditions in developing countries while causing humanitarian crisis and destabilize regions (FM 3-0 2008,1-7). Colloquium attendees stressed that to have an effective response in the environmental security arena it

will likely require multiagency cooperation especially for domestic emergency management and multinational action (Campbell 2008, 16). There are several advocates for military-to-military cooperation and a multinational approach to environmental security. Among them is Dr. Busby, a member of the Council on Foreign Relations, who is a proponent for the U.S. government to develop a "multiyear program with militaries from Africa, Central Asia, South Asia, Latin America, and the Middle East to help facilitate efforts between militaries, thus creating better mutual understandings and cooperation (Busby 2007, 12).

In April 2007, the Center for Naval Analysis (CNA) Corporation released their report, which takes a top-level approach to national security consequences of climate change. The study included a military advisory board to answer how climate change could affect national security over the next 30 to 40 years. The period of 30 to 40 years was selected because that is roughly the amount of time it takes to acquire and build major weapon systems. Specifically the authors, supported by twelve well known retired flag and general officers, set out to answer three questions; What conditions are climate change likely to produce around the world that represent a security risk, What conditions may affect America's security interests, and what actions should the nation take to address national security consequences of climate change? Much of the science and conclusive information published by the authors is similar to conclusions published by the IPCC and NASA's Goddard Institute for Space Studies. For example, the authors acknowledged the effects of climate change over the coming decades include extreme weather events, droughts, flooding, sea-level rise, habitat shift, and life-threatening disease. Scientific data was used to determine under what conditions the nation will be

asked to, with allies or unilaterally, aid in the restoration of weakened and failing governments. In considering all of the challenges, the CNA panel made the five recommendations:

1. The national security consequences of climate change should be fully integrated into national security and national defense strategy and require the intelligence community to incorporate climate consequences into its National Intelligence Estimate.

2. “The U.S. should commit to a stronger national and international role to help stabilize climate change at levels that will avoid significant disruptions to global security and stability.

3. The U.S. government should use its many instruments of national influence, including regional commanders to build partnerships that help less developed nations build the capacity and better manage climate change.

4. “The DoD should enhance its operational capability by accelerating the adoption of improved business processes and innovative technologies that result in improved U.S. combat power through energy efficiency.”

5. “The DoD should conduct an assessment of the impact on U.S. military installations worldwide of rising sea-level, extreme weather events, and other projected climate change impacts over the next 30 to 40 years.”

It is unknown what influence the IPCC, and various DoD sponsored colloquiums had on the *National Defense Strategy* (*NDS*) approved by Secretary of Defense Robert M. Gates, but the *NDS* represents a transformation in the department’s traditional stance in environmental security and climate change. The 2008 *NDS* takes inputs from the President’s 2006 *NSS*, results from the 2006 *Quadrennial Defense Review* and lessons

learned from on-going operations to develop the *NDS*, which serves as the Department's strategic blueprint. The latest *NDS* acknowledges the effects of climate change over the next twenty years in addition to population-pressure, resource, energy, and the environmental could combine with rapid social, cultural, technological and geopolitical change to create greater uncertainty (NDS 2008, 4). The *NDS* further states that environment and climate pressures may generate new security challenges, such future challenges require the Department to begin planning and prepare for climate related changes with existing and future resource. This document is an important step in shaping the Department's mindset. Moreover, it considers future effects of climate change in many aspects of operations from intelligence gathering, planning, and acquisitions of major weapon systems. Clearly, the *NDS* promotes developing partnerships for new situations to assist other countries in improving their security. Placed in the context of environmental security missions, future humanitarian aide and security cooperation missions will most likely occur in southern Asia, Africa, and the Middle East in order to help governments build management capacity. Many of the governments in this region do not have the resources or training to cope with resource scarcity or mass population movements resulting from climate change. By working with governments who are vulnerable to climate change, the U.S. and its allies can help stem much of the violence and disruptions that will occur.

The Obligation of the U.S.

An underlining theme not fully explored in much of the literature is the obligation of the U.S. to respond to environmental degradation. Domestically, the U.S. military is already responding to threats to the homeland in the form of assisting California and

other state firefighters combat intense wildfires which every year burn more acreage than the previous. U.S service members also assist the Border Patrol and provide reconnaissance assistance to the U.S. Coast Guard to help protect our maritime borders. However, internationally the U.S has “incurred on obligation to sustain the global environment that supplies the resources this country thrives on” (King 2000, 6). The U.S has also incurred a responsibility to provide aid because historically it is the largest emitter of greenhouse gases. There are greenhouse gasses in the atmosphere dating back to the industrial revolution, which the U.S. greatly contributed. Internationally, the U.S. is already seen as a climate-villain and the data is widely available to back-up those claims. Finally, the U.S. historically has set precedence for providing aid to countries that have suffered from a natural disaster. The aid-provider precedence is already established and the international communities along with our allies will look to us for assistance and leadership--it is unequivocal.

Summary

In summary, this literature review demonstrates that humans recently became aware of the affect on climate. Climate change science along with the instruments to measure, collect and analyze data began maturing in the 1980s with advent of sophisticated satellites, globally networked sensors and computers capable of producing more realistic global climate models. Environmental Security in the 1990s began to gain traction, however during the George W. Bush administration environmental security along with implications of climate change on national security did not place high on the list of priorities. As such, much of the organizational structure required today to access climate based threats is not in place. The period after 2006 brought with it results of years

and in some cases decades of work with the release of the *IPCC AR4* findings in 2007 and the *2009 Global Climate change Impacts in the U.S.* study. Both studies, which are brilliant combinations of science and collaboration, confirm the planet is headed for a warming trend induced by an unprecedented levels of greenhouse gas emissions. We are at the point where we know enough to act even within the range of uncertainty that still exists. Some of the variations that do exist are in the areas population growth, utilization of resources and most important release of greenhouse gases. All models do indicate if the governments of the world take little or no action to curb greenhouse gases emission in this coming decade the planet as James Hansen predicts, will reach a tipping point where climate change begins feeding on itself. Such a scenario has a real potential to wipeout a majority of the population and species on the planet. On the opposite end, an aggressive move to stabilize and begin reducing greenhouse emissions will slow the effects of climate change allowing governments and population greater time to adjust. The military will be called-up with increasing frequency. The latest version of the *NDS* clearly demonstrates a transformation in the Department's strategic thinking. In a number of *NDS* chapters the Secretary of Defense clearly sends a message that the Department needs to begin preparing for environmental security related missions. That preparation includes working with our allies to begin building governmental capacity to those nations most vulnerable to climate change induced events. At this point, what appears to be lacking is a strategic will in the executive branch and DoD so that clear planning guidance from the top can be disseminated the strategic planning staff.

CHAPTER 3

ANALYTICAL RESEARCH METHODOLOGY

This thesis attempts to answer the primary research question: How should the Department of Defense approach environmental security implications of climate change? The primary question is supported by the two following questions: (1) Does the Department have an environmental security direction? (2) What conditions of climate change are likely to provide security risks to the U.S. in the near term? The answers to the secondary questions assist to adequately frame the problem, explore variables, and develop a proposed response to the primary research question.

The literature review focused on three broad category of documentation, which are: Climate/Science/Environment, Strategic Guidance, and Current DoD publications. To determine the magnitude of security challenges that may result from climate related changes, the literature on the most up-to-date climate related science published by the international and domestic community was reviewed thoroughly. This is essential in order to ascertain the Department's priority in dedicating resources or incorporating environmental security into the planning process. A review of strategic level documentation to include the *National Security Strategy, National Defense Strategy*, and *National Military Strategy* assisted the researcher to establish a historical trend and determine whether the Department has a position on environmental security. The third category of information reviewed is service level documentation such as field manuals along with studies published by the Army Environmental Policy Institute. Further, information presented at colloquiums and publications from private and public institutions are considered.

The methodology selected for this paper is analytical research, which is best suited for topics that attempt to explain why and how. The topic on environmental security and climate change lends itself well to an analytical research method because much of the scientific data deals with cause-and-effect relations among variables.

A systematic process of input followed by Analysis and resulting in a Recommendation is used; see figure 5. This three step approach is direct and applicable to variables involved in analyzing climate related data and environmental security policy. The process accepts various inputs, such as, but not limited to variables in greenhouse gases emission that will produce a conclusive result. The researcher performs a trend analysis and compares the inputs against similar studies produced by different organizations or groups in order to validate or makes adjustments for inconsistent data. The process of analyzing and synthesizing is performed on all data categories.

The outcome of this process is made available in chapter 4 where the analytical methodology is applied to answer the primary and secondary research questions. The analytical framework along with the three stage systematic approach to data analysis provides ample amount of process rigor.

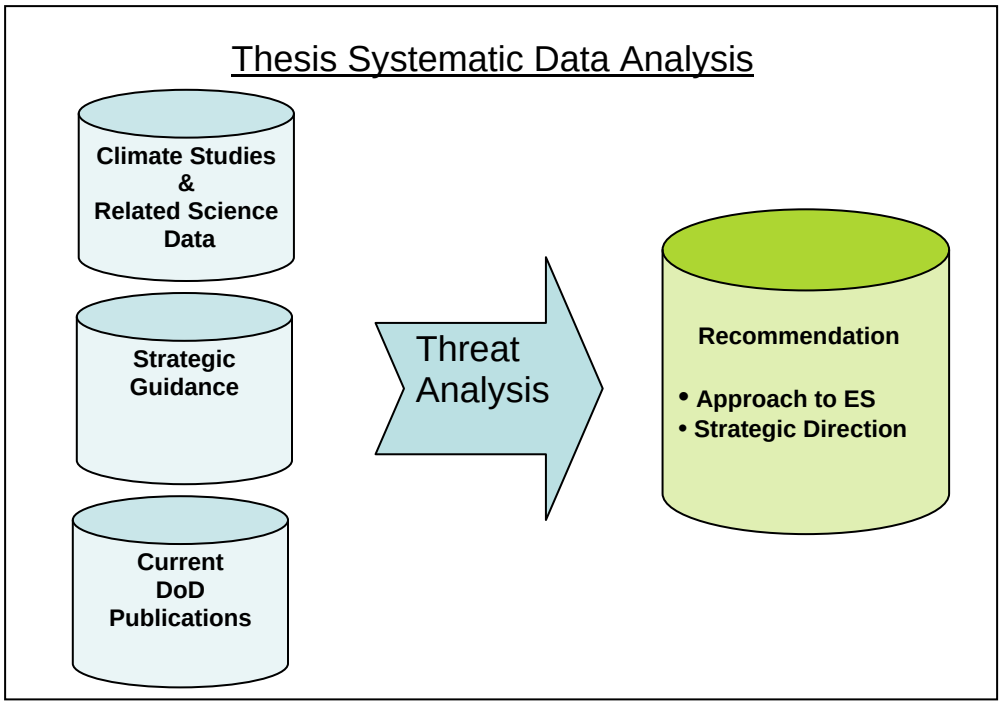

Figure 5. Thesis Systematic Data Analysis

Source: Created by author.

CHAPTER 4

ANALYSIS

As the U.S. maintains a focused approached on irregular warfare in Iraq and Afghanistan, the reality of environmental security risks brought upon by climate change is a distant priority. However, the DoD has a small window of time to organize itself in order to better plan and execute a projected increase in humanitarian and disaster response missions around the globe. This chapter will take a bottoms-up approach by first answering the secondary questions: (1) What condition of climate change are likely to provide security risks to the U.S. in the near term? and (2) Does the Department of Defense have an environmental security direction? which will be followed by the answering the primary question: How should DoD approach environmental security implications of climate change?

Secondary Research Questions

1. What conditions of climate change are likely to provide security risks to the U.S. in the near term?

For the purpose of this question, near term is defined as any impact predicted to occur in the next thirty years. A majority of recently published literature that was reviewed for this report shows a clear indication that climate change is occurring and at current greenhouse gas emission rates, the change is expected to accelerate. The contemporary question surrounding climate change is not if but when and where. The main factor that will determine the severity of climate change is directly related to emissions of greenhouse gas caused by burning fossil fuels. At current greenhouse gas

emissions, all climate models show a significant increase in surface temperatures which will have a direct effect on the planet's precipitation cycles. Largely, precipitation frequency and locations will increasingly change which will reduce overall quality and quantity of available water resources used for drinking, sanitation, and agriculture across many regions. It is estimated that by 2025, 40 percent of the world's population will be living in countries experiencing significant water shortages (CNA 2007). In the near-term, effects of climate change will be more severe in the tropics and gradually impacting the temperate zones.

Of the countries and regions that will begin showing early signs of climate-induced stress, three areas pose near-term national security risks to the U.S. They are; Middle East, Africa, and the Western Hemisphere (tropical zone). Other areas such as southern Asia and the Arctic will be stressed and will experience population shifts and regional disturbances.

The Middle East has some of the world's largest natural gas and oil reserves, which are vital to continued world economic growth. Today, the region controls 66 percent of the world's proven oil reserves (IAGS 2009), yet by some accounts the region is already water stressed. According to the UN at least 23 Middle Eastern countries will suffer significant water shortages by 2025 (Water Wars 1994). Climate change in the form of reduced precipitation coupled with decreasing arable land will limit the area's population carrying capacity. Further, water scarcity together with increasing surface temperature will lower soil moisture contributing to a reduction in crop yields. It will not take long for conditions such as economic disruptions, fighting, mass migration, and the collapse of weak governments to occur due to increased rates of global warming

increasing. All Middle Eastern countries will be affected in one form or the other. However, those countries with significant energy reserves and ocean water access (Saudi Arabia, Iraq, Iran, UAE, Kuwait, and Libya) will have the advantage of building additional desalination plants to counter reduced precipitation, thus making water available for municipal purposes. Constructing desalination plants for agricultural needs is not likely to occur. According to the UN, as of 1995, 1,483 desalination plants were operating in the Arabian Gulf with a combined output estimated at 5.76 million square meters. People living in Israel, Yemen, Oman, and Afghanistan will likely experience unprecedented disruptions, fighting, and begin large migrations to other countries. Mass migrations pose the greatest challenge to Middle Eastern peace. One just needs to look at the decades of persistent fighting between the Israelis and Palestinians over land to get a glimpse of the potential turmoil the region will likely experience in several decades from climate-induced water wars. Based on past and current military engagements along with expected climate induced change, the Middle East poses one of the most serious near-term security challenges to the U.S.

The African continent is both a strategic and humanitarian interest to the U.S. Strategically, the U.S. relies on Africa for key industrial minerals such as bauxite, manganese, platinum, titanium, and uranium. Projections indicate Africa will supply 25 to 40 percent of U.S. oil consumption by 2015 (CNA 2007, 22). Historically, the U.S. has funded a large number of humanitarian and disaster support missions ranging from providing food to curbing the spread of HIV. Like the Middle East, the African continent is showing unequivocal signs of water stress. Lake Chad, which is an important water source for the countries of Chad, Cameroon, Niger, and Nigeria, is rapidly disappearing;

by some estimates, it will disappear in less than ten years (BBC 2006). In addition, since a majority of the African continent falls within the tropic zone boundaries, climate change will continue to alter the continent's water cycle, affecting where and how much water is available. Water change cycles will likely result in water scarcity, increasing fires that contribute to desertification, and a reduction in arable land. There will an increased reliance on a dwindling supply of water from lakes and aquifers. Because many of the countries on the African continent are developing or poor and the governments lack resources to counter the effects of climate change, the governments of several countries could collapse. Climate change will force populations to migrate in search of water, food, and shelter. It is likely populations will begin to migrate to the more temperate zones within the continent and a significant number will seek refuge in the countries of the European Union. The U.S. and allies will face an extremely difficult set of circumstances ranging from genocide to mass population migration management in the African continent.

The Western Hemisphere presents its own set of challenges in the homeland and throughout the Americas. The areas that will experience near-term effects of climate change include the following: Southwest and Southeastern U.S., Central America, and the Caribbean islands.

According to the U.S. Global Change Research Project, "human-induced climate change appears to be well underway in the Southwest" (UGCRP 2009, 133). Recent warming in the region is among the most rapid in the nation and is significantly more than the global average in some areas (UGCRP 2009, 133). In the Southwest, water scarcity is already an issue of concern that many states are finding more difficult to

mange, in part because of prolonged drought and increasing population. Climate change will exacerbate an already difficult water resource situation in the region. Several models show higher surface temperatures and decreasing precipitation will lead to crop failures and a decreasing yield. The models conclude that arable land, temperate crops, and species will begin shifting their habitat northward. Further, western wildfires particularly in California and in the Rocky Mountains will increase in frequency and intensity. The Southeast will experience reduced precipitation pattern similar to the Southwest. The Gulf Cost and Atlantic bordering states will face an increasing trend of tropical storm and hurricane activity. Since the 1970s, the destructive potential of Atlantic hurricanes has increased; such an increase correlates with an increase in sea surface temperatures (Hoyos 2006). Further, studies of the Atlantic and Gulf Cost conclude that because temperatures are increasing, causing greater water evaporations into the atmosphere, there is a growing trend of stronger hurricanes that have the capability to cause more destruction and flooding. With the exception of South Florida, which has some of the country's strictest structural building codes, the vast majority of homes and infrastructure bordering the Atlantic and Gulf Coast are not designed to withstand higher category storms. There is a real potential for future storms to cause devastating damage similar to what was experienced with Hurricane Andrew in 1992 and Hurricane Katrina in 2005. Hurricane Andrew caused over $40 billion in property damage mostly in south Miami and Homestead. Hurricane Katrina is the costliest hurricane in U.S. history--over $90 billion in property damage mainly in New Orleans.

Climate-induced conditions in the Southwest and Southeast will require greater DoD commitment. Already the DoD is involved with the Department of Homeland

Security (DHS) and provides response forces to assist local, state and Federal Emergency Management Agency (FEMA) during periods of disaster. The military will be tasked to assist with disaster and humanitarian response missions along with a growing requirement to support the Forestry Service fight fires. Organizations such as Army Corps of Engineers will be required to assist in a growing trend of civil engineering projects as the country takes proactive measures to limit the effects of climate change and make adjustments to existing infrastructure in order to accommodate population shifts within the country.

As temperatures rise and precipitation patterns change, several Central American countries will experience climatic stress similar to those conditions that the southern U.S. is expected to undergo. Most Central American countries do not have the resources or governmental capacity to address the stress of higher temperatures, reduced water, and an increase in infrastructure damage caused by hurricanes. Of particular concern to the U.S. is Mexico because of its proximity and a population of over 111 million residents, some who currently migrate to the U.S. in search of a better economic situation. Climate change will cause scarcity of water and food. Theses conditions will cause a steep increase in Mexican migration to the U.S. and South America. Many areas in Mexico are already water stressed, in fact, Mexico City is sinking several centimeters a year due to over extraction of groundwater. Water availability and a decrease in arable land will cause increased political instability in Mexico. In addition to Mexico, the smaller countries that makeup Central America such as Belize or El Salvador for example, presents a security concern because it is probable civil strife and destabilization caused by climate-induced have a potential to destabilize the region.

Security concerns presented by the Central American region will require DoD involvement in the areas of border security, stability operations, capacity building, and humanitarian aid. Further, the Department will require support from interagency and allies to provide the necessary manpower and resource to effectively manage regional change.

The third region in the Western Hemisphere that will experience climate-induced change is the Caribbean. Of all the counters in the Western Hemisphere, the 40 island nations in the Caribbean, home to approximately 38 million people (USGCRP 2009, 145) are the most vulnerable to climate change because of limited terrain, infrastructure, and economic capability. Like many of the countries located in the tropics, models indicate precipitation patterns will shift to temperate zones. An aggregate reduction in rain alone is enough to devastate living conditions on most islands, especially smaller islands which solely rely on precipitation to recharge their lakes and aquifers. In addition to reduced precipitation, the islands will experience a growing number of storms and hurricanes, which will devastate aging infrastructure. In some countries such as Cuba, the current operating infrastructure dates back to the 1930s.

Alterations of ocean ecosystems caused by climate change will play an increasing role in decreasing availability of marine species that serve as a vital source of food needed to feed island inhabitants. As Caribbean ocean waters warm, marine species will gradually move northward. Further, according to models produced by the U.S. Global Research Program, sea level rise will play a huge factor in the second half of the 21st century. Rising sea levels will exacerbate the other effects of climate change on the Caribbean islands. The compounding effect of impaired food availability and water

scarcity will likely destabilize the region as refuges from ecological devastation migrate in search of resources. The greatest threat to U.S. national security lies in accommodating millions of ecological refugees from neighboring Caribbean islands, while simultaneously, the U.S. deals with climate-induced change within its own borders.

2. The second supporting question this paper answers is: Does the Defense Department have an environmental security direction? The answer to this supporting question helps frame the analysis required to answer the primary thesis question.

Based on national strategic literature and select service documents reviewed for this paper, the DoD does not have a comprehensive environmental security direction capable of uniting the various services and agencies required to characterize and operationalize environmental security within the Department. Moreover, the department does not appear to have an agreed upon definition of environmental security along with a process to determine how climate change will affect environmental security. Further, it is evident from the literature review that each service appears to be following their own policy of discovery when it comes to environmental security.

Over the past two decades, environmental security issues of climate-induced change have generated significant discussion throughout the DoD and most U.S. government agencies. However, there definitely appears to be a fast-moving realization within the DoD, and for that matter throughout the federal government, that climate-induced change is a reality which the country will have to deal with much sooner than later. Progress on identifying environmental risks to national security slowed down because since September 11, 2001, the U.S. has focused its efforts on homeland security and the war on terrorism. Both Operation Enduring Freedom and Iraqi Freedom have

significantly contributed to the Department's sluggishness in developing environmental security strategy. However, it is evident by a growing number of service sponsored symposiums and colloquiums that the DoD does have a reasonable level of resident expertise needed to operationalize environmental security within the department. Further, the 2008 NDS sends a clear message throughout the Department that climate-induced change will continue to be a growing concern and the DoD needs to begin making internal changes in how it looks and addresses overall environmental security with special focus on climate change.

The Department can learn a few valuable lessons by analyzing the approach NOAA took as lead agency for the U.S. Global Research Program which brought together thirteen separate government agencies along with a number of institutions tasked to analyze climate change and its effects on the U.S. The results of their efforts produced a first of its kind document titled, *Global Climate Change Impacts in the United States*. This keynote publication is one example of synergistic effects the DoD can gain by bringing together organizations such as the Army Environmental Policy Institute, Air Force Air Combat Command and other DoD agencies to help the Department develop climate change strategy.

Primary Research Question

Given the increasing discussions and publication centered on climate change and its affects on national security, this research paper's primary goal is to analyze the DoD's current efforts in addressing the environmental security aspects of climate change. The thesis research question addressed is: How should DoD approach environmental security implications of climate change? Four recommendations are presented to address the

multifaceted approach required to properly develop environmental security strategy. They are:

1. Environmental security must be a component of the national security strategy and national defense strategy.

2. DoD must establish an activity dedicated to develop environmental security and climate change related strategy.

3. Climate change data should be incorporated into a yearly Intelligence Environmental Estimate.

4. Training organizations such as U.S. Joint Forces Command (USJFCOM) should take the lead in developing climate change related training scenarios.

Primarily climate change as an environmental security issue starts at the top in the executive branch. Through the *NSS,* the office of Science and Technology Policy, and Office of Management and Budget, the President sets the Nation's security priority and allocates required resources to ensure those priorities are met. For the defense threats from climate change to be given appropriate priority and for it to take root, the upper levels of the federal government will need to use the four instruments of national power; Diplomatic, Informational, Military, and Economic (DIME). Climate change cannot be dealt with effectively once climate-induced changes are indisputably noticeable--by then it will be too late. Therefore, a DIME approach is required. Starting with diplomacy, the U.S. should change its approach from a country that has taken a minimalist approach on climate related issues to one that takes a lead in developing policy and curbing greenhouse gas emissions. Results of this action alone will provide the DoD with added time; perhaps decades to help counter the effects of climate change and develop

environmental security strategy and tactics. What's more, overall reductions in greenhouse emissions will help produce milder climate change effects, giving Federal agencies and departments more time to adjust to changes. In addition, the U.S. should engage with its allies and foster new relationships to work together on developing solutions and foster international discussions focused on which countries will provide support in the form of aid and personnel to the various regions, particularly those located in the tropics that will experience the initial brunt of climate-induced change.

The informational instrument of national power, perhaps need to be focused internally more so than externally. As James Hansen mentions in his *Tipping Point* paper, that special interest in the U.S. has played a pivotal role in swaying government to take little action to stem growth in fossil fuels. Interestingly, the vast majority of key U.S. departments and agencies have an in-depth understanding of how future climate-induced change will affect the U.S. Unfortunately, climate related information does not appear to effectively be making its way to the public media. Information needs to flow from creditable channels to provide Americans and international partners with the most accurate and latest science. According to a poll conducted by the Pew Research Center in 2009, "only 57 percent of Americans now believe there is strong scientific evidence for global warming, down from 77 percent in 2006." The federal government needs to develop a credible information campaign to inform Americans the dangers climate-induced change presents to the U.S.

The U.S. military will make-up a significant piece of the Nation's environmental and climate change security approach. The DoD along with other key departments will be asked to develop environmental security strategy and policy with the purpose of

identifying limited resources to address national security concerns. Keep in mind that the U.S. will have its own set of climate-induced change issues to deal with, which the military will be required to address by providing support in the form of manpower, equipment, and expertise. The faster environmental security becomes a component of national security, the quicker the DoD can begin analyzing future requirements to determine training and equipping needs. Further, DoD can begin engaging allies such as China's military to develop operations and tactics which specifically address the kinds of missions militaries around the world will encounter as a result of climate-induced change--humanitarian, disaster relief, security cooperation, capacity building and water resource development. Future climate-induced challenges will require DoD to open the aperture and expanded its definition of full spectrum operations.

There is a saying within the DoD acquisition community that an acquisition plan without funding is considered a dream. The same analogy can be drawn in the case of environmental security. Polices at various levels need to have the appropriate funding in order to set priority and allocate resources to cause change. The economic instrument of national power can be used in several areas; one possibility is the area of domestic technology development. The executive branch realizes a need to develop new technology that produces clean energy. President Obama, in a speech given at the Massachusetts Institute of Technology on October 23, 2009, spoke on the need to develop clean-energy alternatives and called on Congress to write legislation to curb climate change. He further told the audience that "the nation that wins this competition is going to be the nation that leads the world" (Boston Globe 2009).

The literature review conducted for this paper reveals a growing trend in an improved understanding of the climate change problem. However, there is a deficit in a clear direction from the Office of the Secretary of Defense (OSD) to provide planning, direction and resources required to develop environmental security strategy. Therefore, the DoD must establish an activity dedicated to creating environmental security related strategy. An activity, which focuses on national security implications of climate change, will go a long way at integrating intelligence and science to gain a better understanding of the cause-and-effect relationship between climate-induced change and social upheavals. For example, the OSD can consider implanting within the DoD an Office of Environmental Security Strategy. See figure 6 for a notional make-up of this organization:

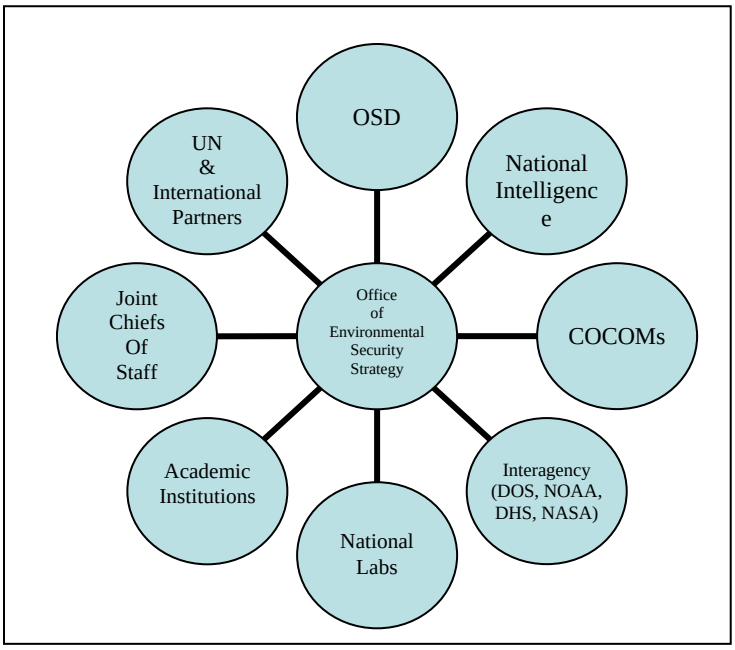

Figure 6. Notional Organization of the Office of Environmental Security Strategy
Source: Created by author.

The purpose of such an organization is to bring together a number of DoD activities exploring climate change implications to national security and join them with other government and institutional activities to expand knowledge and determine options for responding to those climate-induced changes, which threaten national security. The organizational makeup shown in figure 6 is an example of the type of organizations that should form a habitual relationship. It brings together key organizations, which are currently performing climate change related analysis to develop strategy and help operationalize environmental security.

The organization should take its overall strategic direction from OSD; conceptually an Office of Environmental Security and Strategy would operate in a collaborative organizational design. As shown in figure 6 the organization is composed of several independent organizations that include the United Nations, interagency, academic institutions, and the National Intelligence Agency. Suggested independent organizations are currently stakeholders in developing climate change studies and analysis at various levels and geographic regions. Further, independent organizations such as Lawrence Livermore National Lab and/or select academic institutions can perform peer-review studies on a proposed DoD strategy. A peer-review process will not only strengthen policies and strategies produced by the organization, but it will also lend more credibility to it. Inclusion of the Joint Chiefs of Staff and Combatant Command Commanders, allow both the joint community and the Service components to participate in analysis and strategy development.

Resulting strategy from the Office of Environmental Security Strategy will help shape National Military Strategy policy as well as the Department's own position on how

it will handle future missions connected to climate-induced change. The organization will open dialog with interagency and international actors to promote environmental engagement missions and exercises. Such an engagement mission will help the U.S. and allies gauge levels of preparedness of governments in the areas of providing humanitarian relief, disaster response and mitigating civil strife. Take China for example, the DoD spends a great deal of resources evaluating China's national security threat; however, the two countries do not participate in unified military exercises. Considering how economically dependent both countries are to one another and the high level of industrial technological transfer that occurs, both governments should actively participate in military exercises. Environmental engagement is one non-threatening form both militaries can cooperate to gauge their level of humanitarian and disaster response readiness. This knowledge will allow the DoD to determine the areas in the USPACOM AOR that present national security concerns from climate change. Finally, an organization dedicated to producing environmental strategy will help the Department prioritize by providing guidance to Service chiefs and COCOMS on future expected requirements and provide QDR input. Service chiefs and joint commanders will be able to anticipate and prepare the force for an increase in stability and humanitarian type missions. The strategic organization will provide the DoD with a long-range view (at least 20 years) on future national security implication from climate change. This long-range approach can feed into key capability policy documents such the QDR and other joint capability documents to better help the DoD select the right systems and infrastructure for future needs. For example, it is highly likely Diego Garcia, an island located approximately 1000 miles south of India will be inundated by rising sea-levels by

mid century. The island is home to a key air base used by the U.S. Air Force to support forward staging B-1 and B-52 bomber aircrafts. The air base supported aerial bombardment, refueling, and maintenance operations during the 1991 Gulf War and more recently Operation Enduring and Iraqi Freedom. In addition, the island serves as a key communication hub for the U.S. Navy and several DoD satellite systems. An organization such as an office of Environmental Security Strategy can play a vital role in assuring the DoD takes future sea-level rise along with other climate change factors into consideration when selecting or rebuilding infrastructure. Diego Garcia is just one example, there are dozens of key military bases such as MacDill AFB in Tampa, FL, Norfolk Naval Base in Hampton Roads, VA, and Langley AFB in Hampton, VA which will be threatened by rising sea-levels before the end of this century.

Analysis conducted for this chapter recommends that climate change data should be incorporated into a yearly Intelligence Environmental Estimate. This is not a new concept. In 1974, General Maxwell Taylor suggested creating “an expanded National Security Council charged with dealing with all forms of security threats, military and nonmilitary, and having access to all elements of government and to all relevant resources capable of contributing to this broad task” (Campbell 2008, 3). More recently, in 2007, Senators Richard J. Durbin (D-IL) and Chuck Hagel (R-NE) introduced a bill requesting a National Intelligence Estimate produced by the Central Intelligence Agency and the Pentagon to assess national security implications of climate change (Busby 2007, 1).

Just as the current National Intelligence Estimate (NIE) provides decision makers with a coordinated multi-intelligence agency position on potential future events, an

Intelligence Environmental Estimate can help identify areas where climate-induced change will present a likelihood of violence, civil strife, or regional disruption. Analysis by OSD Environmental Security office should analyze the questions of when and what actions should be taken. The author believes it will take several years for many different organizations to normalize and for bureaucratic procedures to conform before comprehensive products to policymakers are made available. For DoD, the main purpose of such an estimate should be to provide actionable intelligence similar to the current NIE, but with the inclusion of how climate-induced change will affect a combatant commanders AOR. This will bring more depth to the analysis and provide commanders with a better understanding of the full-range of missions that his command will be required to accomplish. For example, the *Army Operations Field Manual (FM) 3.0* dated February 27, 2008 provides an introductory description of how climate change will compound and influence operations in the battle-space. It further describes how climate change will lead to humanitarian crisis and regional destabilization. The problem is *FM 3-0* is similar to a number of DoD published documents in that it provides little specificity on what regions will be affected first and what kind of events commanders need to begin training and preparing the force for. More broadly, such an estimate which reaches out to interagency and nongovernment experts can provide the DoD and other key federal government department and agencies with a deep perspective of the areas that pose a near-term risk to national security. While no single set of analysis can precisely describe the future environment, a document such as a yearly Intelligence Environmental Estimate will help ensure the U.S. and its allies are not caught off guard by climate-induced changes that will act as a threat multiplier.

The final analysis conducted in this chapter answers the primary question which results in recommending that training organizations, such as JFCOM, should take the lead in developing climate change related training scenarios. The Joint Warfighting Center (JWFC), which comes under JFCOM maintains resident experts in conducting joint, interagency, and combined exercises. The Center is organized to provide trained, capable, and interoperable forces to the combatant commander. This is accomplished by assisting combatant commanders in conducting mission rehearsal exercises in order to ready the joint forces prior to departing to an AOR.

The training approach required to prepare for future environmental engagements will require a broader partnership with interagency, allies and focus on those likely events to occur from climate-induced change--humanitarian and disaster relief, capacity building, and security cooperation. An example of the kind of interagency and international training required in greater frequency is U.S. Northern Command's Exercise Vigilant Shield conducted with the assistance of JWFC. While this exercise does focus on Homeland Security, it brings together international, interagency and local state authorities to counter threats against the homeland. The kind of environmental engagement missions combatant commanders will execute will require a high degree of coordination with interagency and international partners. Such engagements require the force to maintain a broader understanding of organizations such as DOS, FEMA, NATO, and the UN, just to name a few. Therefore, JFCOM with its vast knowledge in organizing mission rehearsal exercises for all combatant commanders, its close ties with NATO Allied Command for Transformation, and interagency partners should have the lead in environmental engagement exercises that will keep the joint force attuned to evolving global threats.

In summary, this chapter analyzed a number of findings derived from the literature review; providing answers and recommendation to both secondary questions and the primary question. The science is overwhelmingly clear that climate change is unequivocal and the effects of such changes are but a few decades away. The regions impacted first are those that lie in the tropic zone, in part because this is where most of the sunlight is absorbed. Among those regions, the Middle East, Africa, and the Western Hemisphere pose national security concerns to the U.S. At this point in time, the DoD does not have a focused effort dedicated to analyzing climate-induced change and the implications to national security. However, there are several activities within the DoD that tackle climate-change related issues. One key finding is that priority by the executive branch needs to be placed on environmental security. Within the DoD there needs to be a mechanism that provides the Department with long-range strategic guidance regarding climate change. Long-range environmental related guidance will be included in key planning documents such as the *QDR* and factor in to acquisition and infrastructure decisions. Shorter-range information should be included in a National Intelligence and Environment document. This document will provide combatant commanders with information available in the *NIE*, but will also identify environmental hot spots, where resource scarcity will play a significant role in violence, civil strife, or mass-migration. Finally, combatant commanders need to begin training for the types of environmental engagement missions the force will need to respond. Today, USJFCOM, as the joint trainer, is best positioned to help combatant commanders conduct such rehearsal exercises.

CHAPTER 5

RECOMMENDATIONS

Recommendations

This research highlighted the scope and scale of climate change and how national security will be impacted. The IPCC *Fourth Assessment Report* and U.S.Global Cchange Research Program *Global Climate Change Impacts in the United States* present unequivocal evidence that climate-induced change is the single most significant national security challenge facing the world.

Both reports clearly demonstrate human-induced climate change is occurring and the impacts are already apparent. Greater impacts are projected if greenhouse gases emission goes unabated.

This research further highlighted the various DoD communities and organizations at work on the topic of climate change and national security. However, based on national strategic literature and select service documents reviewed, the DoD does not have a comprehensive environmental security direction capable of uniting the various services and agencies required to characterize and operationalize environmental security within the DoD.

The next step DoD needs to take is establish an activity dedicated to analyzing and creating environmental security related strategy. This study recommends DoD should establish an Office of Environmental Security Strategy to help unify the Department's actions. Further the office will provide direction for systematic gathering of climate related information that can be used supplement intelligence and provide guidance in the areas of future engagement areas, training and acquisition.

REFERENCE LIST

Ailworth, Erin. 2009. *Obama hails state of innovation*. Technology. The Boston Globe. October 24.

Alfred, Randy. 2008. "April 1, 1960: First weather satellite launched." *Science. WIRED Magazine*.

Associated Press. 2003. *France heat wave death toll set at 14,802*. USA Today, Weather. September 25.

Bomford, Andrew. 2006. "Slow death of Africa's Lake Chad." *BBC News*. April 14.

Brown, Lester R. 2008. *Plan B 3.0, mobilizing to save civilization*. New York: W. W. Norton and Company, Inc.

Busby, Joshua W. 2007. *Climate change and national security*. New York: Council on Foreign Relations.

Campbell, Kurt M. 2008. *Climatic cataclysm*. Washington, DC: Brookings Institution Press.

Church, John A., Neil J. White, P.J., and John R. Hunter. 2006. "Sea-level rise at tropical Pacific and Indian Ocean islands." *ScienceDirect* 53 (April): 155-168.

Crowell, Mark, Scott Edelman, Kevin Coulton, and Scott McAfee. 2007. "How many people live in coastal areas?" *Journal of Coastal Research* (September).

Engelman, Robert, Michael Renner, Janet Sawin, Ambika Chawla, and Linda Strke. 2009. *2009 state of the world*. New York: W.W. Norton and Company, Inc.

Galton, Francis. 1861. *Meteorographica: The weather of a large part of Europe*. London: Macmillan and Co.

Goodman, Sherri. 2007. *National security and the threat of climate change*. Alexandria: The CNA Corporation.

Grice, Gary K. 2005. *History of weather observing in Washington, D.C. 1821-1950*. Asheville: Midwestern Regional Climate Center.

Hansen, James. 2008. *Tipping point: Perspective of a climatologist*. Washington, DC: Island Press.

Hoekstra, Peter. 2007. "Environmental intelligence" *The Wall Street Journal*, Opinion. May 10.

Homer-Dixon, Thomas. 2009. *Carbon shift, how the twin crisis of oil depletion and climate change will define the future*. Canada: Random House Canada.

Houghton, John. 2004. *Global warming, the complete briefing*. Cambridge: Cambridge University Press.

Institute for the Analysis of Global Security (IAGS). "Future of Oil." http://www.iags.org/ futureofoil.html (accessed October 19, 2009).

Intergovermental Panel on Climate Change (IPCC). 2007a. *Climate change 2007: Impacts, adaptation and vulnerability*. Contribution of Working Group 2 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press.

———. 2007b. *Climate Change 2007: Impacts, adaptation and vulnerability*. Summary for Policymakers. Contribution of Working Group 2 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press.

———. 2007c. *Climate change 2007: Mitigation*. Summary for Policymakers. Contribution of Working Group 3 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press.

———. 2007d. *Climate change 2007: The physical basis*. Summary for Policymakers. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press.

———. 2007e. Synthesis Report. *Climate Change 2007*. Contribution of Synthesis Working Group to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press.

Joyce, Matt. 2009. "Forest official: Beetle-killed trees a future in Wyoming, Colorado." *The Aspen Times*. January 15.

Karl, Thomas R., Jerry M. Melillo, and Thomas C. Peterson, U.S. Global Change Research Program. 2009. *Global climate change impacts in the United States*. New York: Cambridge University Press.

King, W. Chris, Colonel. 2000. *Understanding international environmental security: A strategic military perspective*. Atlanta: Army Environmental Policy Institute.

Kleypas, J. A. 2005. *Impacts of ocean acidification on coral reefs and other marine calcifiers*. Report sponsored by the National Science Foundation, the National Oceanic and Atmospheric Administration, and the U.S. Geology Survey. April.

Mabey, Nick. 2008. *Delivering climate security*. Philadelphia: Routledge.

Mideast News Portal. Water Wars. http://www.mideastnews.com/WaterWars.htm (accessed October 19, 2009).

National Aeronautics and Space Administration (NASA). "News & Features." http://www.nasa.gov/topics/earth/features/earth_temp.html (accessed July 17, 2009).

———. "Overview." http://nssdc.gsfc.nasa.gov/earth/nimbus.html (accessed July 8, 2009).

National Intelligence Council. 2009. *China: Impact of climate change to 2030*. Washington, DC: Government Printing Office.

Pumphrey, Carolyn. 2008. *Global climate change: National security implications*. Carlisle: U.S. Army War College.

Turabian, Kate L. 2007. *A manual for writers.* 7th ed. Chicago: University of Chicago Press.

U.S. Army. 2008. Field Manual 3-0. Washington, DC: Government Printing Office.

———. Command and General Staff College. 2008. ST 20-10, *Master of military art and science (MMAS) research and thesis.* Ft. Leavenworth, KS: USA CGSC, July.

U.S. Department of Defense. 2004. *National military strategy*. Washington, DC: Government Printing Office.

———. 2006. *Quadrennial defense review report*. Washington, DC: Government Printing Office.

———. 2008. *National defense strategy*. Washington, DC: Government Printing Office.

U.S. Executive Office. 1999. The *National Security Strategy of the United States of America*. Washington, DC: Government Printing Office.

———. 2006. The *National security strategy of the United States of America*. Washington, DC: Government Printing Office.

U.S. Global Change Research Program (USGCRP). 2009. Global Climate Change impacts in the United States. New York: Cambridge University Press.

U.S. Joint Forces Command. 2008. *The joint operating environment: Changes and implications for the future joint force.* Norfolk: Government Printing Office.

U.S. Senate. 2000. Testimony of Richard S. Lindzen before the U.S. Senate Commerce Committee. http://www.john-daly.com/TAR2000/lindzen.htm (accessed October 17, 2009).

INITIAL DISTRIBUTION LIST

Combined Arms Research Library
U.S. Army Command and General Staff College
250 Gibbon Ave.
Fort Leavenworth, KS 66027-2314

Defense Technical Information Center/OCA
825 John J. Kingman Rd., Suite 944
Fort Belvoir, VA 22060-6218

Dr. W. Chris King
Dean of Academics
USACGSC
100 Stimson Avenue
Fort Leavenworth, KS 66027-2301

Mr. Allan S. Boyce
DLRO
USACGSC
100 Stimson Avenue
Fort Leavenworth, KS 66027-2301

LTC Michael R. Anderson
DAO
USACGSC
100 Stimson Avenue
Fort Leavenworth, KS 66027-2301