

REPORT DOCUMENTATION PAGE**Form Approved**
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Service, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) 14-03-2010	2. REPORT TYPE Master of Military Studies Research Paper	3. DATES COVERED (From - To) September 2009 - April 2010
4. TITLE AND SUBTITLE Climate Change Implications to the Global Security Environment, U.S. Interests, and Future Naval Operations		5a. CONTRACT NUMBER N/A
		5b. GRANT NUMBER N/A
		5c. PROGRAM ELEMENT NUMBER N/A
6. AUTHOR(S) Lieutenant Commander Jessica O'Brien, United States Navy		5d. PROJECT NUMBER N/A
		5e. TASK NUMBER N/A
		5f. WORK UNIT NUMBER N/A
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USMC Command and Staff College Marine Corps University 2076 South Street Quantico, VA 22134-5068		8. PERFORMING ORGANIZATION REPORT NUMBER N/A
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A		10. SPONSOR/MONITOR'S ACRONYM(S) N/A
		11. SPONSORING/MONITORING AGENCY REPORT NUMBER N/A
12. DISTRIBUTION AVAILABILITY STATEMENT Unlimited		
13. SUPPLEMENTARY NOTES N/A		
14. ABSTRACT The effects of climate change are intertwined with existing political, social, cultural, and economic issues, which have significant implications for U.S. interests around the world. These effects are reshaping the national security environment, which pose great changes for DOD priorities. Climate change interacts with other issues such as weak governments, poor economies, and population growth, which drive vulnerable states toward instability. As climate change progresses, the United States will be drawn more frequently into unstable situations where weakened states cannot support the basic needs of their populations or maintain security. The National Security Strategy, the Quadrennial Defense Review, and the Naval Operations Concept address the need to mitigate the effects of climate change. The Navy must prepare for expanded operations and more frequent engagements around the globe. In the operating environment, the Navy must reduce its dependency on fossil fuels, adapt to changing ocean environments and weather patterns, and assess critical infrastructure susceptible to rising sea levels. Strategically, the Navy must prepare for increased humanitarian operations and determine the best solution to meet the demand signal. Additionally, national emphasis on the Arctic region increasingly requires Navy involvement. The Navy must work together with other stakeholders to ensure a safe and secure Arctic region.		
15. SUBJECT TERMS Climate Change, Security, Naval Operations		

INSTRUCTIONS FOR COMPLETING SF 298

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 26	19a. NAME OF RESPONSIBLE PERSON Marine Corps University / Command and Staff College
a. REPORT Unclass	b. ABSTRACT Unclass	c. THIS PAGE Unclass	19b. TELEPHONE NUMBER (Include area code) (703) 784-3330 (Admin Office)		

--	--	--	--	--	--

INSTRUCTIONS FOR COMPLETING SF 298

1. REPORT DATE. Full publication date, including day, month, if available. Must cite at least the year and be Year 2000 compliant, e.g., 30-06-1998; xx-08-1998; xx-xx-1998.

2. REPORT TYPE. State the type of report, such as final, technical, interim, memorandum, master's thesis, progress, quarterly, research, special, group study, etc.

3. DATES COVERED. Indicate the time during which the work was performed and the report was written, e.g., Jun 1997 - Jun 1998; 1-10 Jun 1996; May - Nov 1998; Nov 1998.

4. TITLE. Enter title and subtitle with volume number and part number, if applicable. On classified documents, enter the title classification in parentheses.

5a. CONTRACT NUMBER. Enter all contract numbers as they appear in the report, e.g. F33615-86-C-5169.

5b. GRANT NUMBER. Enter all grant numbers as they appear in the report, e.g. 1F665702D1257.

5c. PROGRAM ELEMENT NUMBER. Enter all program element numbers as they appear in the report, e.g. AFOSR-82-1234.

5d. PROJECT NUMBER. Enter all project numbers as they appear in the report, e.g. 1F665702D1257; ILIR.

5e. TASK NUMBER. Enter all task numbers as they appear in the report, e.g. 05; RF0330201; T4112.

5f. WORK UNIT NUMBER. Enter all work unit numbers as they appear in the report, e.g. 001; AFAPL30480105.

6. AUTHOR(S). Enter name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. The form of entry is the last name, first name, middle initial, and additional qualifiers separated by commas, e.g. Smith, Richard, Jr.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES). Self-explanatory.

8. PERFORMING ORGANIZATION REPORT NUMBER. Enter all unique alphanumeric report numbers assigned by the performing organization, e.g. BRL-1234; AFWL-TR-85-4017-Vol-21-PT-2.

9. SPONSORING/MONITORS AGENCY NAME(S) AND ADDRESS(ES). Enter the name and address of the organization(s) financially responsible for and monitoring the work.

10. SPONSOR/MONITOR'S ACRONYM(S). Enter, if available, e.g. BRL, ARDEC, NADC.

11. SPONSOR/MONITOR'S REPORT NUMBER(S). Enter report number as assigned by the sponsoring/ monitoring agency, if available, e.g. BRL-TR-829; -215.

12. DISTRIBUTION/AVAILABILITY STATEMENT. Use agency-mandated availability statements to indicate the public availability or distribution limitations of the report. If additional limitations/restrictions or special markings are indicated, follow agency authorization procedures, e.g. RD/FRD, PROPIN, ITAR, etc. Include copyright information.

13. SUPPLEMENTARY NOTES. Enter information not included elsewhere such as: prepared in cooperation with; translation of; report supersedes; old edition number, etc.

14. ABSTRACT. A brief (approximately 200 words) factual summary of the most significant information.

15. SUBJECT TERMS. Key words or phrases identifying major concepts in the report.

16. SECURITY CLASSIFICATION. Enter security classification in accordance with security classification regulations, e.g. U, C, S, etc. If this form contains classified information, stamp classification level on the top and bottom of this page.

17. LIMITATION OF ABSTRACT. This block must be completed to assign a distribution limitation to the abstract. Enter UU (Unclassified Unlimited) or SAR (Same as Report). An entry in this block is necessary if the abstract is to be limited.

United States Marine Corps
Command and Staff College
Marine Corps University
2076 South Street
Marine Corps Combat Development Command
Quantico, Virginia 22134-5068

MASTER OF MILITARY STUDIES

TITLE:

Climate Change Implications to the Global Security Environment, U.S. Interests, and Future
Naval Operations

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

AUTHOR:

Lieutenant Commander Jessica J. O'Brien, USN

AY 10-11

Mentor and Oral Defense Committee Member: Dr. Pauletta Otis

Approved: *Pauletta Otis*

Date: 14 March 2011

Oral Defense Committee Member: Dr. Edward Erickson

Approved: *Edward Erickson*

Date: 14 MARCH 2011

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENT AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

QUOTATION FROM, ABSTRACTION FROM, OR REPRODUCTION OF ALL OR ANY PART OF THIS DOCUMENT IS PERMITTED PROVIDED PROPER ACKNOWLEDGEMENT IS MADE.

TABLE OF CONTENTS

	Page
DISCLAIMER.....	i
TABLE OF CONTENTS.....	ii
PREFACE AND ACKNOWLEDGEMENTS.....	iii
EXECUTIVE SUMMARY.....	iv
INTRODUCTION.....	1
SECTION 1: PHYSICAL EFFECTS OF CLIMATE CHANGE.....	2
SECTION 2: SOCIOECONOMIC EFFECTS OF CLIMATE CHANGE	5
SECTION 3: SECURITY EFFECTS OF CLIMATE CHANGE.....	7
SECTION 4: CONCLUSION.....	19
ENDNOTES.....	20
APPENDIX A: GLOBAL WARMING TREND.....	22
APPENDIX B: PREDICTED GLOBAL IMPACTS OF TEMPERATURE INCREASES.....	23
APPENDIX C: ALTERNATE SHIPPING ROUTE THROUGH THE NORTHERN SEA.....	24
BIBLIOGRAPHY	25

PREFACE AND ACKNOWLEDGEMENTS

I chose this topic for both personal and professional reasons. As an oceanography major at the United States Naval Academy, I particularly enjoyed studying polar oceanography. In 1996, I researched and wrote a paper on climate change effects on the development of polar sea ice. During this time I had the opportunity to work with many professionals at the National Ice Center who were on the cutting edge of what was then the relatively new topic of global climate change.

During my fourteen years as a Surface Warfare Officer, I have maintained an interest in oceanography and climate change, and have observed firsthand humanitarian and disaster relief operations, which the Navy increasingly is called upon to respond. In my research, I found that the U.S. Government, the Department of Defense, and the Navy in particular have recognized the issue of climate change and are working to identify the effects climate change will have on the full spectrum of operations. The Navy must maintain the ability to conduct its enduring core capabilities, but it must also prepare to adapt to changes in the operating environment as a result of climate change.

Many thanks to the numerous individuals who provided me with their guidance and knowledge, as well as, a most important resource, their time, significantly enhancing my personal advancement on this subject.

To my parents, for raising me steps from the Gulf of Mexico and instilling in me a love and deep appreciation for the water.

EXECUTIVE SUMMARY

Title: Climate Change Implications to the Global Security Environment, U.S. Interests, and Future Naval Operations

Thesis: This paper aims to identify the physical and socioeconomic changes occurring across the globe as a result of climate change and relate them to evolving security challenges. Security challenges exist on several levels, first on a global scale, then specific impacts to the U.S. and its interests, and finally to the Navy and its future operations.

Discussion: The effects of climate change are intertwined with existing political, social, cultural, and economic issues, which have significant implications for U.S. interests around the world. These effects are reshaping the national security environment, which pose great changes for DOD priorities. Climate change is a factor that interacts with other issues such as weak governments, poor economies, and population growth, which drive vulnerable states toward instability. As climate change progresses, the United States will be drawn more frequently into unstable situations where weakened and failing states cannot support the basic needs of their populations or maintain security. From the National Security Strategy to the Quadrennial Defense Review to the Naval Operations Concept of the sea services, these documents address the need to develop further a plan to mitigate the effects of climate change. The Navy must prepare for expanded operations, more frequent engagements around the globe, and a higher demand signal. Both the Navy's operating and strategic environment are affected by climate change. In the operating environment, the Navy must look to reduce its dependency on fossil fuels, adapt to changing ocean environments and weather patterns, and assess critical infrastructure susceptible to rising sea levels. Strategically, the Navy must prepare for increased humanitarian operations and determine the best solution to meet the demand signal. Additionally, national emphasis on the Arctic region increasingly requires Navy involvement. The Navy, along with other Arctic stakeholders must work together to ensure a safe and secure Arctic region.

Conclusion: The impacts of climate change will have significant implications to national security on a strategic, operational, and tactical level, and will cross domestic and international boundaries. Extreme weather events around the globe followed by their second and third order effects will endanger populations, damage critical infrastructure, and require employment of military assets. Countries with weak governments and poor economies are particularly vulnerable to climate change, which could lead to refugee and humanitarian crises. The Defense Department's recognition of climate change in the Quadrennial Defense Review marked a step forward in reevaluating long-term strategies, identifying potential issues, and planning enhanced military operations due to climate change effects. Continuing partnerships between the White House, Department of State, Department of Defense, and numerous other stakeholder agencies are imperative as the United States seeks to mitigate climate change effects to U.S. strategic interests at home and abroad. The Department of the Navy is leading the DOD in recognizing the potential impact of climate change and has positioned itself to make wide-ranging adaptive changes to its operations and force structure

INTRODUCTION

"All across the world, in every kind of environment and region known to man, increasingly dangerous weather patterns and devastating storms are abruptly putting an end to the long-running debate over whether or not climate change is real. Not only is it real, it's here,"
*President Barack Obama*¹

The debate over climate change has been gaining momentum for well over a decade. On any given day, climate change and its increasingly visible effects are making the news around the world. The effects of climate change are inextricably intertwined with existing political, social, cultural, and economic issues, which have significant implications for U.S. interests around the globe.² These effects are reshaping the national security environment which poses great changes for Department of Defense (DOD) priorities.

The 2010 Quadrennial Defense Review (QDR) uses the term "instability accelerant" when referring to climate change. Climate change is a factor that interacts with other issues such as weak governments, poor economies, and population growth which drive vulnerable states toward instability.³ Although the United Nations plays a large role in managing emergencies which result from climate change, the U.S. continues to be called upon as a first responder immediately following natural disasters or anywhere humanitarian assistance is deemed necessary by the U.S. or the international community.⁴

Within the United States Government, climate change and its global security impact must be addressed comprehensively between many agencies to include the White House, Department of State, and Department of Defense (DOD). Partnerships are key in developing a comprehensive strategy to anticipate and mitigate climate change effects. As merely one stakeholder among many, it is unlikely that the DOD will be the lead agency in addressing climate change issues. As a result, it is imperative that the DOD adequately defines its priorities

and challenges in response to issues attributed to climate change and ensures its voice is heard.⁵ This is a difficult task given the lack of fidelity in climate change projections. Planning, budgeting, and acquisition decisions must be made with the information currently available, although the scientific community continues to refine predictions of climate change and its effects.

The sea services – the Navy, Marine Corps, and Coast Guard, more than the other armed services, are witnessing the effects of climate change on a daily basis in places like the Arctic where ice is melting at an alarming rate, opening new sea lines of communications and bringing to light new security issues. In response, the Navy has been proactive and is leading the DOD in addressing these new challenges. This paper aims to identify the physical and socioeconomic changes occurring across the globe as a result of climate change and relate them to evolving security challenges. These security challenges exist on several levels, first on a global scale, then specific impacts to the U.S. and its interests, and finally to the Navy and its future operations.

SECTION 1: PHYSICAL EFFECTS OF CLIMATE CHANGE

“Even the minimum predicted shifts in climate for the 21st century are likely to be significant and disruptive.” United Nations Framework Convention on Climate Change⁶

The predicted physical effects of climate change must first be identified before an accurate analysis of security implications can be completed. As the climate change debate continues, one fact has unequivocally been established – the earth is warming. In 2007, the Intergovernmental Panel on Climate Change (IPCC) reported that the earth’s climate is warming based on scientific data which indicates increases in atmospheric and ocean temperatures around the world, extensive snow and ice melting, and a steady increase in sea levels.⁷ However, the rate at which the earth is warming, the causes for warming, and the mitigation measures to

reverse warming remains a point of contention in the scientific community. Over the past century, average global temperatures rose by more than 1° F and in some regions by as much as 4° F. The oceans have also warmed, especially in the Arctic and Antarctic.⁸ (Appendix A) The scientific community predicts that surface and ocean temperatures could rise as much as 11° F by the end of the century, causing dramatic and adverse changes to the climate with profound consequences for the earth and its inhabitants. For every degree of temperature increase, profound and often irreversible damage occurs in the environment from desertification of land to increased intensity of storms to decline in crop yields. (Appendix B)

Many impacts of climate change are already occurring and are under observation by scientists. One of these is the melting of land-based ice around the globe. Mountain glaciers are in retreat around the globe and immeasurable amounts of ice are lost each year due to the melting and slipping of glacier ice into the ocean, adding billions of tons of water to the oceans annually. Both the Greenland ice sheet and the Antarctic ice sheet are losing mass twice as fast as predicted. It is estimated that these ice sheets will reach an unknown threshold at some point where they will become unstable and cause rapid, uncontrollable sea level rise.⁹ Scientific sea level rise scenarios estimate that by the end of the century a global sea level increase of 1 meter is not only plausible but likely a low estimate. In addition, if one of the polar ice sheets becomes unstable, sea levels could potentially rise by more than 5 meters.¹⁰

Sea ice in the Arctic has also seen drastic declines in recent years. Climate change effects have been amplified in the region, so much so, that sea ice has declined three times faster than computer models initially predicted. In 2007, Arctic sea ice shrank more than had ever been observed since scientists began recording data in 1979. The consequence of sea ice decline is threefold. First, sea ice reflects sunlight very effectively while open water absorbs sunlight. As

sea ice melts, more sunlight will be absorbed by open water, adding to the overall warming trend and intensifying climate change. Second, sea ice is home to many marine mammals and provides their food sources. The delicate ecosystem residing in the Arctic will become extinct as sea ice continues to retreat.¹¹ Finally, retreating sea ice has opened the Northern Sea Route and the Northwest Passage for longer periods during the summer, allowing transit between Northern Europe and the Far East, a 35-60 percent savings in distance as compared to transit via the Panama or Suez canals.¹² (Appendix C)

Another effect of climate change is extreme weather events, which have become a more common occurrence in recent years. This trend is expected to continue due to changes in local weather patterns caused by climate change. More intense hurricanes and typhoons, such as Hurricane Katrina, are predicted due to increased ocean surface temperatures which fuel the unstable low pressure weather systems. Not only is the average atmospheric temperature rising, the incidence of extreme atmospheric temperatures is increasing as well, leading to more frequent heat waves and high temperature extremes. Significant rainfall events are also occurring more frequently which causes an increase in flash flooding. As a whole, these extreme weather events are expected to increase over the next several years causing adverse effects to “coastal communities, human health, water quality and availability, and agriculture”.¹³

Lastly, climate change is affecting ecosystems around the world. Plants and animals across the spectrum are affected, those on land, in oceans, and in freshwater lakes and rivers. Ecosystems particularly at risk are those in the polar regions, as discussed above, coral reefs in the tropics, and tropical rainforests. These ecosystems are hypersensitive to changes in temperature, precipitation, and salinity. The risk of extinction for species in these ecosystems increases as temperatures increase.¹⁴ Additionally, mosquitoes and other disease carrying insects

are expected to extend their ranges as a result of temperature increases and changing weather patterns.

Drawing from the physical effects of climate change discussed above, the most drastic effect will be to the quality and quantity of water around the globe. Although, different regions will be affected in different ways, it is expected that regions of the world which are already dry will get drier and likewise regions prone to a large amount of precipitation will receive increasingly more precipitation. The repercussions of this change will have a dramatic impact on the human population around the globe.

SECTION 2: SOCIOECONOMIC EFFECTS OF CLIMATE CHANGE

"Climate change will have wide-ranging implications for the United States over the next 20 years. This is because it will aggravate existing problems such as poverty tensions, environmental degradation, ineffectual leadership and weakened political institutions that threaten state stability," Major General Richard Engel, director of the Climate Change and State Stability Program, Office of the Director of National Intelligence¹⁵

The physical effects of climate change will trigger adverse socioeconomic changes. There will be a shortfall of water for drinking and irrigation, which adds the risk of thirst and famine. The world's population largely depends on water from the seasonal melting of alpine snow and ice. The quality of drinking water will be impacted as sea levels rise and saltwater infiltrates freshwater resources. Increased rainfall and flooding in areas could overwhelm local water infrastructure causing an increase in contaminants and sediment to the water supply. Additionally, more agricultural fertilizer and municipal sewage could be washed into coastal waters by flooding and increased rainfall causing "dead zones".¹⁶

As climate change progresses and intensifies, shifts in human migration patterns are inevitable. According to the United Nations, by 2050, the world's population is estimated to be

9 billion and over 90 percent of this growth will take place in developing nations. Today there are estimated to be 214 million migrants globally, by 2050 that number is expected to nearly double, due in large part to climate migration.¹⁷ Refugees affected by natural disasters can usually return home, but future climate migrants could be permanently forced from their homes due to scarcity of resources, food, and water exacerbated by natural disasters. Additionally, in many cases, climate migration occurs in regions which are already unstable and volatile making the potential for border conflicts and security concerns even greater.

Climate change will have a wide spectrum of adverse effects on global health, particularly in developing nations. Increased rates and extended ranges of malaria, dengue fever, and other insect-borne diseases are predicted in countries experiencing significant rainfall. Conversely, airborne diseases will thrive in areas more susceptible to drought. Additionally, shortages of food and water will leave populations more susceptible to illness.¹⁸

The risk of a pandemic also increases with large numbers of climate migrants. Repercussions of a pandemic will be felt both economically and politically due to loss of life, diverting resources to immediate medical crises, and restrictions placed on the movement of goods across borders of countries. Countries dependent upon tourism will be affected disproportionately economically. A country's political climate can quickly and drastically change in a health crisis depending on the government's capability to respond. Perceived preference of medical treatment to a particular ethnic, religious, or political group could spark unrest. Regardless of the scenario, the UN, other international organizations, and developing countries look to the U.S. for help in responding to health crises and will continue to do so. Climate change will only increase the likelihood of such occurrences.¹⁹

Changes and declines in agricultural prosperity will also occur as a result of increased temperature, changes in rainfall, and insect patterns. “Crop ecologists estimate that for every 1.8°F rise in temperature above norms, grain production will decrease by 10 percent.”²⁰ An excellent example of how climate related factors could push a marginal situation beyond the tipping point is in Darfur. A conflict arose between herders and farmers when herders lost their land to the desert after a long drought. The herders were forced to migrate in search of water and fertile land, coming into conflict with farmers occupying the land. When “coupled with population growth, tribal, ethnic, and religious differences, the competition for land turned violent.”²¹

SECTION 3: SECURITY IMPLICATIONS OF CLIMATE CHANGE

“The stresses that climate change will put on our national security will be different than any we’ve dealt with in the past...this is why we need to study this issue now, so that we’ll be prepared and not overwhelmed by the required scope of our response when the time comes.”
*Vice Admiral Richard Truly, Director, Department of Energy National Renewable Energy Lab*²²

Climate Change Implications on the Global Security Environment

As discussed above, the physical effects of climate change – rising sea levels, rising temperatures, drought, and extreme weather lead to the socioeconomic effects of climate change - famine, migration, and disease. These are all stressors that many developing countries are not prepared to cope with. The effects are “interwoven and self-perpetuating”: water shortages lead to a shortage of food, which can then lead to a pandemic, which can force mass migration of populations, which ultimately can lead to food shortages in new regions.²³

From this stems a myriad of security implications. But first, the question of ‘what is security’ needs to be addressed. In broad terms, security refers to freedom from the risk of loss or damage to a thing that is important to survival and well-being. The concept of human security

which continues to evolve can be defined as a “concern with human life and dignity”, which when broken down into components includes “economic, food, health, environmental, personal, community, and political factors.”²⁴ Stable societies require access to these fundamental resources, most importantly food and water. When a government cannot provide these resources, deliver services to its people, ensure domestic order, and protect its borders and citizens, a vacuum is created leaving conditions ripe for conflict, extremism, and acts of terrorism.²⁵

The threats of climate change effects are significant and not equally distributed globally. Some governments will be more affected than others. By looking at history and through predictions, those most affected by climate change will be states that are under-developed, fragile, and undemocratic. Developing nations do not have the government, infrastructure, or technical capabilities to adapt to climate change. Their ability to prevent or even adequately react to humanitarian disasters is inadequate. Weak or failing states experience some of the same issues as developing states. Often these states suffer from the absence of a strong government, repressed populations, weak economies or lack of border control, which leave the governments unable to respond adequately to humanitarian crises. Finally, populations of undemocratic states are vulnerable to climate change effects because their governments have no incentive or often no desire to protect the population at large. Democracies, where leaders must be responsive to the people or they will be voted out of office, generally are not susceptible to severe humanitarian crises.²⁶

Although climate change effects will most likely not be the primary cause for breakdowns in security, they will certainly be a factor. In reviewing the three major threats to security, most significant is violence and armed conflict. With the change in quality and quantity

of vital natural resources such as fresh water, fertile farmland, and marine resources due to climate change, competition for these resources will increase. The incidence of violence and armed conflict could be more likely and be prolonged as populations struggle to secure resources.²⁷ There are numerous examples where this is already being seen today in places such as Somalia and Darfur. As global temperatures rise and resources become scarcer, the frequency and duration of violence is expected to increase.

Natural disasters are already a significant security threat as observed in the wake of events such as the Haiti earthquake in 2010 and the Southeast Asia tsunami in 2005. “Between 1990 and 1999, an estimated 188 million people per year were affected by natural disasters, six times more than the 31 million affected by armed conflict.”²⁸ As global temperatures increase, the incidence and severity of natural disasters will also increase, leaving behind refugees. Those affected will suffer from disease, malnutrition, loss of income and a lack of security. In weak and developing states where the capacity or willingness to help the affected populations is lacking, these issues will be exacerbated.

The physical effects of climate change such as drought, disease, and economic stagnation are destabilizing forces and have the potential to act as tipping points causing state failures to become more likely. The spread of disease such as malaria due to climate change has the potential to destabilize vulnerable nations. A recent World Health Organization study estimates that as many as 160,000 deaths occur annual from the secondary effects of climate change such as disease and malnutrition. Predications indicate that numbers could double by 2020.²⁹

Climate Change Implications on U.S. Security Interests

Given the information above which indicates that climate change is occurring and it will increasingly have adverse impacts around the globe, the question to be answered is what impact

will this have on the United States and its security environment? At a minimum as climate change progresses, the United States will be drawn more often into unstable situations where weakened and failing states cannot support the basic needs of their populations or maintain security. The United States, as the world's "911 force" will be called upon more frequently in times of need. Additionally, as Arctic sea ice melts an entirely new geographic region, once virtually inaccessible, will be open for commercial and military activity. As this change occurs, the United States must increase its Arctic presence to protect its interests and ensure security, safety, and stability in the region.

For many years there were questions at the highest levels of government on whether the scientific evidence of climate change was enough to warrant the United States' attention and whether climate change would pose a threat to the nation's security. In the past two years, enough actionable scientific data has proven that climate change is occurring and that it is an issue that must be addressed. Although there is still much to be learned from scientific data about climate change, the administration now considers climate change to be a justifiable national security concern.

From the President's National Security Strategy to the Department of Defense's Quadrennial Defense Review to the Naval Operating Concept of the sea services, these documents over the past few years have addressed the need to develop further a plan to address the effects of climate change. Starting with the National Security Strategy of 2010, climate change is identified as a key challenge facing our nation. It states that "the change wrought by a warming planet will lead to new conflicts over refugees and resources; new suffering from drought and famine; catastrophic natural disasters; and the degradation of land across the

globe.”³⁰ The U.S. is charged with confronting this challenge based upon scientific information and in cooperation with nations around the globe.

Within the Department of Defense, the National Defense Strategy references current and future environmental and climate issues as security challenges which must be addressed.³¹ Additionally, the QDR presented to congress in early 2010 took a huge step forward in addressing climate change by laying out the DOD’s “vision for its missions and force structure in the face of anticipated threats.” The document identified climate change as a destabilizing agent and discussed how military operations will be affected and how the military should respond to climate-related disasters. It further stated that climate change will have a “significant geopolitical impact” around the world and will contribute to “poverty, environmental degradation, and the further weakening of fragile governments.”³²

The QDR goes on to state, “while climate change alone does not cause conflict, it may act as an accelerant of instability or conflict, placing a burden to respond on civilian institutions and militaries around the world.” Additionally, “extreme weather events may lead to increased demands for support to civil authorities for humanitarian assistance and disaster relief. Proactive engagement in these countries can help build their capability to respond to such events.”³³

In a similar vein, the QDR also for the first time addressed the effect of climate change on the DOD’s operating environment, specifically the Arctic. The opening of Arctic waters which now permits commerce and transit presents new opportunities and security challenges for the United States and all Arctic countries.

Narrowing in scope, the 2010 Naval Operations Concept (NOC 10), a joint Navy-Marine Corps-Coast Guard document states that social instability in over-populated cities, especially those that exist in already unstable parts of the world, has the potential to create dire situations

and armed conflict. The effects of climate change may “amplify human suffering through catastrophic storms, loss of arable lands, and coastal flooding and could lead to loss of life, population migration, social instability, and regional crises”. The NOC 10 references the specific mission of humanitarian assistance/disaster relief (HA/DR) as a core capability of the sea services which is expected to increase as a result of climate change effects.³⁴ Given its forward presence, inherent mobility, and flexible capabilities, naval assets are often the force of choice for such missions. From 1970 through 2000, U.S. forces were involved in 366 humanitarian missions as compared to 22 combat-related missions for that same period.³⁵

The core capability of HA/DR is broken down into two categories. First, proactive HA/DR is defined as the enduring, rotational missions focused on building critical partner capacity and improving disaster response readiness in targeted countries through training and relationship building. The Navy is currently participating in missions such as PACIFIC PARTNERSHIP in Southeast Asia and CONTINUING PROMISE in Central and South America. Reactive HA/DR, on the other hand is a crisis response operation which employs naval expeditionary capabilities to meet the urgent needs of a partner nation. Given its unique organization, global presence, and self-sufficiency, the naval service is uniquely postured to respond to disasters, both natural and man-made around the globe.³⁶

Climate Change Implications for Naval Operations

Drawing on the scientific evidence of climate change, its effects on human populations, and the current guidance promulgated by the President, Secretary of Defense, and Chief of Naval Operations (CNO), the Navy must prepare for expanded operations, more frequent engagements around the globe, and a higher demand signal. As the global highway for more than 90 percent

of worldwide trade and a source of sustenance for billions of people, the world's oceans are the lifeblood of the planet and the global population.³⁷

The 2007 Maritime Strategy identifies the Navy's enduring core capabilities as forward presence, deterrence, sea control, power projection, maritime security, and humanitarian assistance/disaster response.³⁸ Each of these capabilities and the Navy's ability to conduct them will be affected by climate change as both the Navy's operating and strategic environment is affected.

The operating environment ranges from the political to the physical. The political environment in which the Navy as an organization operates increasingly has been putting more pressure on the DOD to curb spending and trim energy consumption. As more and more legislation is passed by Congress for federal agencies to trim their energy usage, the Navy will be required explore the use of alternative fuels and monitor and control greenhouse gas emissions. Higher energy prices have been putting a strain on the Navy's budget for many years, requiring difficult choices to be made between funding for procurement, maintenance, and operations. As one of the largest consumers of fossil fuels, which are the number one source of man-made greenhouse gases, the Navy must look to alternative fuel sources.³⁹ Showing the Navy's level of commitment to making positive changes for the environment, the CNO established Task Force Energy in 2010, which is charged with formulating a strategy and plan for reducing the Navy's reliance on fossil fuels.

The physical environment is changing as well, although the Navy is very adept at operating in dynamic ocean environments. The difficulty is the tremendous uncertainty regarding the when and where and the extent of changes that will occur. Some considerations that the Navy must prepare for include change in water densities, salinity, and acidity due to the

infusion on more freshwater into the oceans from ice melt. Water density affects mobility of submarines making it more difficult to maintain neutral buoyancy at depth and it also affects sonar capabilities for both submarines and surface ships. Acidity changes the underwater acoustic properties which could have adverse affects on long-established predictions of propagation paths which are critical to anti-submarine warfare. Additionally, accurate sonar detection is critical in detecting underwater ridges.⁴⁰

Climate change induced modifications to surface conditions also have the ability to affect surface operations. Changes in ocean currents due to Arctic ice melt have the potential to drastically impact the climate in the North Atlantic region and navigation routes used by the Navy. Severe weather events have huge impacts on the Navy from operations and maintenance to mobility. Today, the Navy's answer to extreme weather is avoidance. The Naval Meteorological and Oceanography Command provides weather forecasting to the Navy's operational forces to avoid extreme weather. In the future, if the incidence of extreme weather increases as is predicted, it could be more difficult for ships to avoid these events. High sea states have many adverse effects on surface ships from curtailing flight operations, re-charting courses causing longer transits, the possible damage to super-structures and sonar domes, and the increased risk to personnel. Increased temperatures can also impact operational readiness. In places like the Arabian Gulf where temperatures can reach well over 120°F, equipment and personnel are put under great strain. High operational tempo in these conditions increases the risk of mishaps, and takes a toll on the physical and mental well-being of personnel.⁴¹

Another critical vulnerability facing the Navy is its infrastructure, specifically port facilities which are vulnerable to rising sea levels and extreme weather. In the United States and around the world, the Navy relies on port facilities, both military and commercial. Disruption of

port facilities has the potential to affect the Navy on several levels. First, a key mission of the Navy is to keep sea line of communications and access routes open for trade. In the event of port disruptions, the Navy could be called upon to intervene. Second, the Navy relies on port facilities around the world during deployments for maintenance, fuel, and supplies. Port disruptions could have adverse impacts on the Navy's sustainability at sea during extended deployments. Finally, military shipbuilding facilities which support the defense industrial base are located in at-risk areas along the coasts. An example of the impact of extreme weather on shipbuilding facilities has already been realized on the Gulf Coast during Hurricane Katrina in 2005. Several ships under construction in New Orleans and Pascagoula experienced schedule delays due to damage sustained during the hurricane.⁴² Vulnerability assessments of naval facilities will be critical in preparing for the consequences of climate change. Evaluations will help determine at-risk facilities and response plans can then be developed to mitigate risks.⁴³

To address climate change issues, the Navy must anticipate the changes in the future operating environment, although it may be difficult to accurately define today. Preparing for multiple scenarios will require the Navy to expand its cooperation with other agencies, both governmental and civilian, and other nations. Over the past several years, the Navy has embraced a formal lessons learned database which spans across all warfare areas and missions. Expanding this database to address relevant climate change information including best practices in response to climate change and making it available to relevant agencies such as the Coast Guard is needed. Climate change cannot be addressed by the Navy in a vacuum. Information sharing will be imperative to meeting the forthcoming challenges posed by climate change.⁴⁴

Just as important as the changes in the Navy's operating environment due to climate change, the strategic environment will undergo many changes as well. As discussed earlier, the

Navy must anticipate an increase in humanitarian assistance operations. Natural disasters and armed conflict resulting from climate-induced migration, resource scarcity, and state failure speak directly to the Navy's strategic priorities and core capabilities.

The Navy has proven time and again that it is the force of choice when responding to humanitarian crises. There are, however, improvements and efficiencies to be gained in preparing for and executing these operations. Although in times of crises, the Navy has successfully responded around the globe, in an environment of increased humanitarian need, the Navy is at risk of not being capable to meet the demand signal. A solution is an expanded, routine presence through the Global Fleet Station concept. The Navy has the capability to bolster the capacity of local governments through routine engagement in the form of exercises and training.⁴⁵ The ongoing Africa Partnership Station mission is an example. Through the employment of one amphibious ship and carefully selected embarked detachments of aviation assets, Naval Mobile Construction Battalion assets, and medical assets, the Africa Partnership Station has become a model for security cooperation.

Another asset which requires review to ensure its full integration and utilization is the Military Sealift Command (MSC). MSC operates several types of ships from oilers to combat stores ships to Maritime Prepositioning Ships, which are deployed around the globe in support of naval combatants and are capable of embarking large quantities of humanitarian assistance supplies. The range of MSC ships can carry fuel, ammunition, and food, and many have enhanced dry stores capacity. These vessels have not participated in humanitarian assistance missions in the past, but due to their stores capacity and forward-deployed capability could be a critical asset during a crisis.

Given that climate change is expected to affect coastal nations at a higher rate than landlocked nations, the Navy should look to expand its capability to operate in the littorals. Maritime crises of today no longer look like the large-scale blue water naval battles of the past. The focus on independent operations in the littorals where ships can support freedom of navigation operations and mediate between foreign navies in dispute over fisheries and economic exclusion zones, are operations that the Navy must increasingly be prepared for. The Littoral Combat Ship (LCS) is one answer to this issue. Today, the Navy has two LCS in its inventory with several more under construction to meet a goal of 55 upon completion of the class. The versatility of this platform lies in its speed, shallow draft, and flexible mission modules. The mission modules are a plug-and-play concept where warfare modules ranging from anti-submarine warfare to surface warfare to mine warfare have the capability of being swapped out in one to two days in a designated port anywhere around the world. In addition, these ships are scheduled to be forward deployed as sea bases around the world with rotating crews. When fully implemented, this concept will give the Navy far more flexibility to execute missions and remain on-station indefinitely.

Finally, the Navy is paying particular attention to the unique issues emerging in the Arctic region. In 2009, the Navy approved an Arctic Roadmap which gives specific guidance for the way-ahead in developing policy, strategy, and force structure in the region. The Arctic is strategically important to the United States and particularly the Navy. Scientific evidence has confirmed that the climate in the Arctic is changing much more rapidly than in any other region around the world. In 2009, and for the first time in recorded history, several German cargo vessels transited the Northern Sea route unaided by icebreakers. It is anticipated and likely that the door has been opened for much more commercial traffic to transit this route in the future.

Rich fossil fuel reserves, the prospect of eco-tourism, and the potential fuel savings for commercial shipping by transiting the Northern Sea during ice-free conditions make the Arctic particularly alluring.

The United States as a whole has virtually no footprint currently in the region, although the Navy has a long history of operating in there. In 2009, President Bush signed the Arctic Region Policy which declared that the “United States is an Arctic nation, with varied and compelling interests in that region.”⁴⁶ It went on to “direct the departments of State, Homeland Defense, and Defense to develop greater capabilities and capacity to protect U.S. borders; increase Arctic maritime domain awareness; preserve global mobility; project a sovereign American maritime presence; encourage peaceful resolution of disputes; cooperate with other Arctic nations to address issues attributed to increased shipping and to establish a risk-based capability to address hazards to include search and rescue (SAR), basing and logistical support.”⁴⁷ This directive was a clear indication to the Navy that it must be prepared to increase Arctic engagement.

Today the only surface assets in the U.S. inventory capable of operating in the Arctic are three Coast Guard icebreakers. They play a critical role in Arctic operations, particularly SAR missions, which will only increase as the region becomes more navigable. The Navy has not yet invested in icebreaking ships, although it will likely be necessary in the near future as the Northern Sea and Northwest Passage become more accessible. An option for the Navy is to retrofit current ships with an icebreaking capability. Although, likely more expensive due to the extensive strengthening of the hull and alterations required to the propellers, retrofitting would most certainly have a more timely turnaround than would procuring a new class of icebreaking ships.

There is much work required and challenges to overcome to ensure a safe and secure Arctic region. These include an increase in infrastructure and logistics support, improved navigational aids and nautical charts of the region, and improved interagency communications. The Navy's Arctic Roadmap, stresses the importance of cooperative partnerships to meet the objectives as delineated in the Arctic Region Policy. The Navy must continue to strengthen its relationship with the Coast Guard and ensure the two services and all U.S. stakeholders in the Arctic are working together to meet the overall responsibilities of the U.S. as an Arctic nation.

SECTION 4: CONCLUSION

"We have many advantages in the fight against global warming, but time is not one of them. Instead of idly debating the precise extent of global warming, or the precise timeline of global warming, we need to deal with the central facts of rising temperatures, rising waters, and all the endless troubles that global warming will bring. We stand warned by serious and credible scientists across the world that time is short and the dangers are great. The most relevant question now is whether our own government is equal to the challenge." Senator John McCain⁴⁸

The future implications of climate change are increasingly becoming clear, although the magnitude of the shift remains in question. At a minimum, increasing environmental stressors will have some degree of socioeconomic impact around the globe. As a first responder, the United States must anticipate a wide-spectrum of second and third order effects of climate change and be prepared to meet the challenge.

The impacts of climate change will have significant implications to national security on a strategic, operational, and tactical level, and will cross domestic and international boundaries. Extreme weather events around the globe will endanger populations, damage critical infrastructure, and require employment of military assets. Countries with weak governments and poor economies are particularly vulnerable to climate change, which could lead to refugee and humanitarian crises.

The United States cannot face this issue in alone, nor can it move forward in developing solutions and mitigating strategies in a vacuum. Continuing partnerships between international organizations such as the United Nations are critical as the White House, Department of State, Department of Defense, and numerous other stakeholder agencies seek to mitigate climate change effects to U.S. strategic interests at home and abroad.

The Defense Department's recognition of climate change in the Quadrennial Defense Review in 2010 marked a step forward in reevaluating long-term strategies, identifying potential issues, and planning enhanced military operations due to climate change effects. The Department of the Navy is leading the DOD in recognizing the potential impact of climate change and has positioned itself to make wide-ranging adaptive changes to its operations and force structure. Guided by the National Security Strategy, Naval Operations Concept 2010, and the Maritime Strategy and facilitated by today's leadership, the Navy must continue to steer a smart course in meeting the climate change challenge head-on.

¹Barack Obama, "Energy Independence and the Safety of Our Planet Speech." (speech, Chicago, Illinois, April 3, 2006).

² Commander Herbert E. Carmen, Christine Parthemore, and Will Rogers, "Broadening Horizons: Climate Change and the U.S. Armed Forces" (Center for a New American Security, April 2010), 5.

³ Christine Parthemore and Will Rogers, "Promoting the Dialogue: Climate Change and the Quadrennial Defense Review" (Working paper, Center for a New American Security, January 2010), 8.

⁴ John Podesta and Peter Ogden, "The Security Implications of Climate Change" *The Washington Quarterly* (Winter 2007-2008): 132.

⁵ Carmen, "Broadening Horizons," 13.

⁶ United Nations Framework Convention on Climate Change. "A Question of Degree," accessed on March 2, 2010, http://unfccc.int/essential_background/feeling_the_heat/items/2905.php.

⁷ Sharon Burke et al., "Uncharted Waters: The U.S. Navy and Navigating Climate Change" (Working paper, Center for a New American Security), 11.

⁸ The Pew Center on Global Climate Change, *Climate Change 101: Understanding and Responding to Global Climate Change* (Jan 2009), 1.

⁹ The Pew Center, *Climate Change 101*, 5.

¹⁰ Kurt M. Campbell, Editor, *Climatic Cataclysm: The Foreign Policy and National Security Implications of Climate Change* (Washington D.C.: Brookings Institution Press, 2008), 58-61.

¹¹ The Pew Center, *Climate Change 101*, 5.

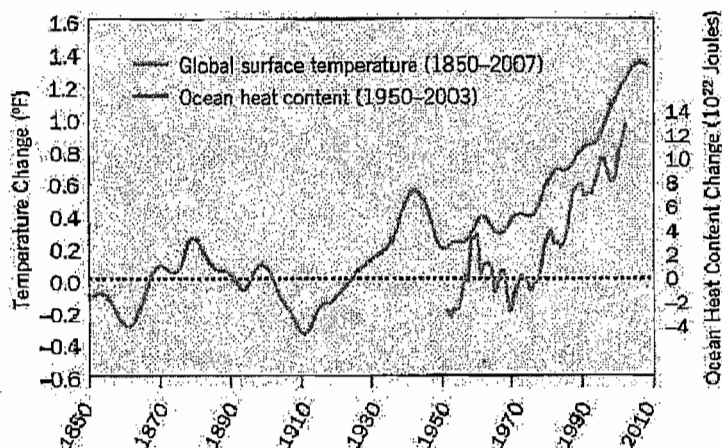
¹² David W. Titley and Courtney C. St. John, "Arctic Security Considerations and the U.S. Navy's Roadmap for the Arctic" *Naval War College Review* (Spring 2010): 39.

¹³ The Pew Center, *Climate Change 101*, 6.

¹⁴ The Pew Center, *Climate Change 101*, 6.

-
- ¹⁵ Patricia Kime, "The Climate Challenge," *Seapower* (May 2010): 56.
- ¹⁶ The Pew Center, *Climate Change 101*, 7.
- ¹⁷ Michael Werz and Kari Manlove, "Climate Change on the Move" (Center for American Progress, December 8, 2006), 1-2.
- ¹⁸ Podesta, "The Security Implications of Climate Change," 123.
- ¹⁹ Podesta, "The Security Implications of Climate Change," 125.
- ²⁰ The CNA Corporation, *National Security and the Threat of Climate Change* (2007), 15.
- ²¹ The CNA Corporation, *National Security and the Threat of Climate Change* (2007), 15.
- ²² House Committee on Science and Technology, Subcommittee on Energy and Environment. *Statement of Rear Admiral David Titley, Oceanographer of the Navy and Director, Task Force Climate Change*, 112th Cong., 1st sess., November, 17, 2010, http://democrats.science.house.gov/Media/file/Commdocs/hearings/2010/Energy/17nov/Titley_Testimony.pdf (accessed March 2, 2011).
- ²³ Podesta, "The Security Implications of Climate Change," 116.
- ²⁴ Jon Barnett, Richard A. Matthew, and Karen L. O'Brien, *Global Environmental Change and Human Security* (Cambridge, Massachusetts: The MIT Press, 2010), 5-8.
- ²⁵ The CNA Corporation, *National Security and the Threat of Climate Change*, 16.
- ²⁶ Nigel Purvis and Joshua Busby, "The Security Implications of Climate Change for the UN System." Chap. In *Environmental Change and Security Project Report* (Washington D.C.: Woodrow Wilson International Center for Scholars, 2004), 2.
- ²⁷ Purvis, "The Security Implications of Climate Change," 2.
- ²⁸ Purvis, "The Security Implications of Climate Change," 2.
- ²⁹ Purvis, "The Security Implications of Climate Change," 2.
- ³⁰ White House, *National Security Strategy* (Washington, DC, May 2010), 47.
- ³¹ U.S. Department of Defense, *National Defense Strategy* (Washington, DC: U.S. Department of Defense, June 2008), 5.
- ³² Michael Werz and Kari Manlove, "Quadrennial Defense Review Should Spark Interagency Climate Conversation" (Center for American Progress, February 11, 2010), 1-4.
- ³³ U.S. Department of Defense, *Quadrennial Defense Review Report* (Washington, DC: U.S. Department of Defense, February 2010), 85.
- ³⁴ U.S. Department of the Navy, *Naval Operations Concept 2010*, (Washington DC: U.S. Department of the Navy, 2010), 46-48.
- ³⁵ U.S. Department of the Navy, *Naval Operations Concept 2010*, 46.
- ³⁶ U.S. Department of the Navy, *Naval Operations Concept 2010*, 47-48.
- ³⁷ U.S. Department of the Navy, *A Cooperative Strategy for 21st Century Seapower*, (Washington, DC: U.S. Department of the Navy, October 2007), 2.
- ³⁸ U.S. Department of the Navy, *A Cooperative Strategy for 21st Century Seapower*, 12-14.
- ³⁹ Burke, "Uncharted Waters," 17.
- ⁴⁰ Burke, "Uncharted Waters," 19.
- ⁴¹ Burke, "Uncharted Waters," 20-21.
- ⁴² Burke, "Uncharted Waters," 24.
- ⁴³ Burke, "Uncharted Waters," 25.
- ⁴⁴ Burke, "Uncharted Waters," 21.
- ⁴⁵ U.S. Department of the Navy, *Naval Operations Concept 2010*, 31.
- ⁴⁶ Titley, "Arctic Security Considerations," 43.
- ⁴⁷ Titley, "Arctic Security Considerations," 43.
- ⁴⁸ John McCain, "Energy Independence and the Safety of Our Planet Speech." (speech, Chicago, Illinois, May 12, 2008).

APPENDIX A: GLOBAL WARMING TREND – AVERAGE SURFACE WARMING AND OCEAN HEAT CONTENT



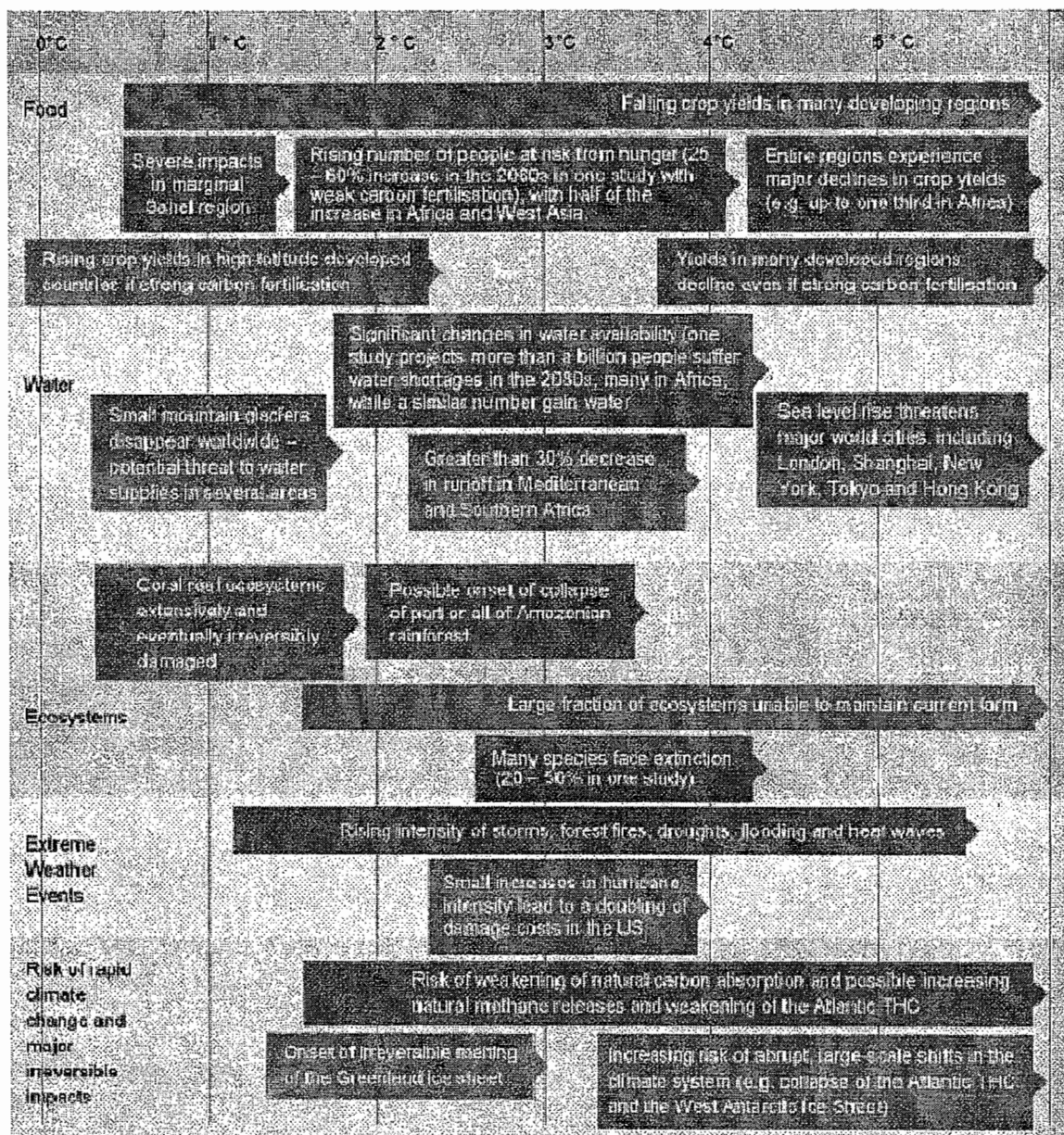
Global average surface temperature change (left axis) and ocean heat content change in upper 2300 feet (right axis).

SOURCES

Surface temperature: Brohan, P., J.J. Kennedy, S.F.B. Tett, and P.D. Jones. "Uncertainty estimates in regional and global observed temperature changes: A new dataset from 1850." *Journal of Geophysical Research* 111, no. D12106 (2006): doi: 10.1029/2005JD006548.

Ocean heat: Domingues, C.M., J.A. Church, N.J. White, P.J. Gleckler, S.E. Wijffels, P.M. Barker and J.R. Dunn. 2008. "Improved estimates of upper-ocean warming and multi-decadal sea-level rise." *Nature* 453:1090-1093.

APPENDIX B: PREDICTED GLOBAL IMPACTS OF TEMPERATURE INCREASES



Source: <http://www.ice.org.uk/patoolkit/Planning/Climate-change>

APPENDIX C: ALTERNATE SHIPPING ROUTE THROUGH THE NORTHERN SEA

A Shortcut Across The Top of the World

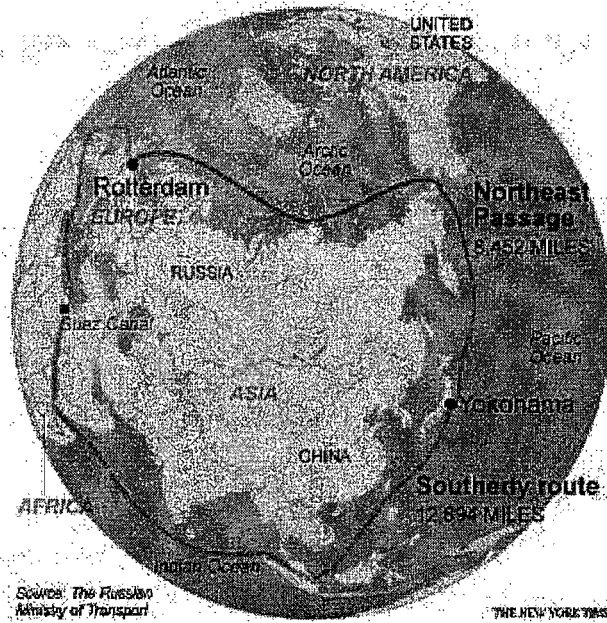
The Northeast Passage, across the Arctic Ocean, provides a shorter alternative for cargo vessels travelling between Europe and Asia than using the Suez Canal. It is shorter than the Panama Canal route for some voyages between the North American west coast and Europe.

LENGTH OF A VOYAGE TO ROTTERDAM FROM:

YOKOHAMA, JAPAN
12,894 miles via Suez Canal,
8,452 miles via Northeast Passage

SHANGHAI, CHINA
12,107 miles via Suez Canal,
9,297 miles via Northeast Passage

VANCOUVER, CANADA
10,262 miles via Panama Canal,
8,036 miles via Northeast Passage



Source: <http://daniellemeitiv.com/2009/09/11/arctic-shortcut-a-reality-and-likely-to-speed-arcticwarming-and-melting/>

BIBLIOGRAPHY

- Barnett, Jon, Richard A. Matthew, and Karen L. O'Brien. *Global Environmental Change and Human Security*. Cambridge, Massachusetts: The MIT Press, 2010.
- Burke, Sharon, Dr. Jay Gulledge, Dr. Michael Horowitz, Christine Parthemore, and Nirav Patel. "Uncharted Waters: The U.S. Navy and Navigating Climate Change." Working paper, Center for a New American Security, December 2008.
- Campbell, Kurt M., Editor. *Climatic Cataclysm: The Foreign Policy and National Security Implications of Climate Change*. Washington D.C.: Brookings Institution Press, 2008.
- Carmen, Commander Herbert E., Christine Parthemore, and Will Rogers. "Broadening Horizons: Climate Change and the U.S. Armed Forces," Center for a New American Security, April 2010.
- Climate and Energy Symposium 2010, *Proceedings on Climate and Energy: Imperatives for Future Naval Forces*, 23-24 March 2010.
- Kime, Patricia. "The Climate Challenge." *Seapower*, May 2010.
- Obama, Barack. "Energy Independence and the Safety of Our Planet Speech." Chicago, Illinois. April 6, 2006.
- Parthemore, Christine and Will Rogers. "Promoting the Dialogue: Climate Change and the Quadrennial Defense Review." Working paper, Center for a New American Security, January 2010.
- Podesta, John and Peter Ogden. "The Security Implications of Climate Change." *The Washington Quarterly*, Winter 2007-2008: 115-138.
- Purvis, Nigel and Joshua Busby. "The Security Implications of Climate Change for the UN System." Chap. in *Environmental Change and Security Project Report*. Washington, D.C.: Woodrow Wilson International Center for Scholars, 2004.
- The CNA Corporation, *National Security and the Threat of Climate Change*, 2007.
- The Pew Center on Global Climate Change, *Climate Change 101: Understanding and Responding to Global Climate Change*, January 2009.
- Titley, David W. and Courtney C. St. John. "Arctic Security Considerations and the U.S. Navy's Roadmap for the Arctic." *Naval War College Review*, Spring 2010, Vol. 63, No. 2.
- U.S. Congress. House. Committee on Science and Technology, Subcommittee on Energy and Environment. *Statement of Rear Admiral David Titley, Oceanographer of the Navy and Director, Task Force Climate Change*. 112th Cong., 1st sess., November 17, 2010.

http://democrats.science.house.gov/Media/file/Commdocs/hearings/2010/Energy/17nov/Titley_Testimony.pdf (accessed March 2, 2011).

U.S. Department of Defense. *National Defense Strategy*. Washington, DC: U.S. Department of Defense, June 2008.

U.S. Department of Defense, *Quadrennial Defense Review Report*. Washington, DC: U.S. Department of Defense, February 2010.

U.S. Department of the Navy. *A Cooperative Strategy for 21st Century Seapower*. Washington, DC: U.S. Department of the Navy, October 2007.

U.S. Department of the Navy. *Naval Operations Concept 2010*. Washington DC: U.S. Department of the Navy, 2010.

United Nations Framework Convention on Climate Change. "A Question of Degree." Accessed March 2, 2010. http://unfccc.int/essential_background/feeling_the_heat/items/2905.php.

Werz, Michael and Kari Manlove. "Climate Change on the Move," Center for American Progress, December 8, 2009.

Werz, Michael and Kari Manlove. "Quadrennial Defense Review Should Spark Interagency Climate Conversation," Center for American Progress, February 11, 2010.

White House. *National Security Strategy*, May 2010.