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NATIONAL SECURITY IMPLICATIONS OF GLOBAL CLIMATE CHANGE

JOINT HEARING

BEFORE THE

SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING

AND

SUBCOMMITTEE ON INTELLIGENCE, COMMUNITY MANAGEMENT, PERMANENT SELECT COMMITTEE ON INTELLIGENCE HOUSE OF REPRESENTATIVES

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JOINT HEARING ON NATIONAL SECURITY IMPLICATIONS OF GLOBAL CLIMATE CHANGE

WEDNESDAY, JUNE 25, 2008

HOUSE OF REPRESENTATIVES, SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING, JOINT WITH THE SUBCOMMITTEE ON INTELLIGENCE, COMMUNITY MANAGEMENT, PERMANENT SELECT COMMITTEE ON INTELLIGENCE,

Washington, DC.

The committees met, pursuant to call, at 9:40 a.m., in Room 210, Cannon House Office Building, Hon. Edward J. Markey [chairman of the Select Committee on Energy Independence and Global Warming] presiding.

Present from the Select Committee on Energy Independence and Global Warming: Representatives Markey, Blumenauer, Inslee, Herseth Sandlin, Cleaver, Hall, McNerney, Sensenbrenner, and Walden.

Present from the Permanent Select Committee on Intelligence Subcommittee on Intelligence Community Management: Representatives Reyes, Eshoo, Thompson, Murphy, Hoekstra, Tiahrt, and Issa.

Staff present: Ana Unruh Cohen.

The CHAIRMAN. Ladies and gentlemen, thank you all so much for being here at a joint hearing of the Select Committee on Energy Independence and Global Warming and the Select Committee on Intelligence and the Subcommittee on Intelligence Community Management.

I want to thank Chairman Reyes and Chairwoman Eshoo, Ranking Member Issa and the rest of the members of the Subcommittee on Intelligence Community Management for joining us today for this important hearing, and Mr. Sensenbrenner, the ranking member of the Select Committee on Global Warming, and our members as well.

We find ourselves at a critical moment in history. The impacts of our altered atmosphere from the burning of fossil fuels are beginning to manifest themselves in the United States and around the world. Our response to this challenge can be to either unleash a technology revolution that will enhance our national economic and environmental security or to burden the planet with climactic catastrophe.

Whether it is floods in Iowa, cyclones in Burma, or drought, starvation and genocide in Darfur, we know that environmental threats underpin many global conflicts and crises, and that global

warming will only make matters worse, and that human beings all over the planet face death or famine or injury if we do not act.

The select committee's very first hearing focused on the geopolitical implications of our Nation's dependence on oil and the impacts of global warming. That inaugural hearing occurred in the same week that the U.N. Security Council held its first-ever discussion on the implications of global warming for international peace and security, and the same week that 11 retired top U.S. military leaders and the Center for Naval Analysis issued the report, "National Security and the Threat of Climate Change."

We are honored to have two key participants in those efforts with us today: the Honorable Margaret Beckett, the former Foreign Secretary of the United Kingdom, and Vice Admiral Paul Gaffney.

One of the key recommendations of the CNA report was for the Intelligence Community to incorporate the consequences of climate change into a National Intelligence Estimate. After that first select committee hearing, I introduced legislation requiring such an analysis. Through the hard work of Chairwoman Eshoo and her colleagues on the House Intelligence Committee, similar language was included in the House Intelligence Authorization Bill last year.

The Director of National Intelligence has since responded with the National Intelligence Assessment, finalized earlier this month, and which informs much of today's hearing. Unfortunately, the NIA is classified, and therefore the public cannot benefit from the excellent analysis that the Intelligence Community has brought together in this report.

But make no mistake, this first-ever high-level Intelligence Community study of global warming, which calls the climate crisis "a threat to American security," is a clarion call to action from the heart of our Nation's security establishment.

I understand the reasoning behind the decision of the National Intelligence Council to classify the specific regional security impacts of global warming in this NIA, but I am reserving my judgment as to whether that is the right choice.

The science is conclusive. We know that global warming is occurring today, and we know that severe security consequences will result. I believe that our goal must be to marshal the political will to halt and roll back global warming and save the planet from this disaster.

The Intelligence Community is hesitant to tell the world who will be affected, what might happen, and where the greatest security risks will occur. But that is exactly what we need. If people know specifically what those severe security problems will be and where they will be and who they will affect, then perhaps we will finally have enough political will, both in this country and internationally, to do the hard work of solving the climate crisis.

After 7 years of ignoring the problem, the Bush administration continues to limit what their experts can communicate to the public on this critical issue. Whether it is the Environmental Protection Agency or the National Intelligence Council that is sounding the alarm, whether it is a danger to the public or a danger to national security, the President doesn't want America to know the real risks of global warming.

I would now like to recognize the gentlelady from California, Ms. Eshoo, for an opening statement. And then I will recognize the two ranking members from the minority.

[The prepared statement of Mr. Markey follows:]

Opening Statement for Edward J. Markey (D-MA)
"National Security Implications of Global Climate Change"
Joint Hearing of the
Select Committee on Energy Independence and Global Warming
And the
Subcommittee on Intelligence Community Management
June 25, 2008

This joint hearing is called to order.

I want to thank Chairwoman Eshoo, Ranking Member Issa and the rest of the Members of the Subcommittee on Intelligence Community Management for joining us today for this important hearing.

We find ourselves at a critical moment in history. The impacts of our altered atmosphere from the burning of fossil fuels are beginning to manifest themselves in the United States and around the world. Our response to this challenge can be to either unleash a technological revolution that will enhance our national, economic and environmental security or to burden the planet with climatic catastrophe. Whether it is floods in Iowa, cyclones in Burma or drought, starvation and genocide in Darfur, we know that environmental threats underpin many global conflicts and crises, and that global warming will only make matters worse.

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I would now like to recognize the Gentlelady from California, Chairwoman Eshoo.

Ms. ESHOO. Thank you, and good morning, Mr. Chairman.

I think that what I would like to do is to ask the chairman of the House Intelligence Committee, because I know he has other commitments this morning, to make his statement, and then I can follow.

Mr. Chairman.

Mr. REYES. Thank you, Chairwoman Eshoo and Chairman Markey, and the ranking members as well, for conducting this very important hearing.

I think this is vitally important, that we provide the forum for all these exceptional witnesses to provide us the information and the benefit of their expertise, because this is an issue that we all realize we have to contend with, whether it is in terms of operational considerations, certainly budget considerations, but most importantly, as a grandfather, the implication that it means for future generations, not just in this country but throughout the world.

So I think this is certainly an important hearing and one of a series of opportunities that we will have, as a Congress, to factor this issue into everything that we do. So I appreciate the opportunity to be here, and we will follow it closely.

Thank you.

The CHAIRMAN. I thank the chairman very much.

And now we continue to yield to the gentlelady from California, Ms. Eshoo.

Ms. ESHOO. Thank you to Chairman Markey and, certainly, to the chairman of the full Committee on Intelligence in the House, to all of my colleagues here.

A special welcome to our witnesses.

I want to start out by noting the historic nature of this hearing today. It is extraordinary because it represents the very first time that the Government of the United States is acknowledging the national security implications of global climate change.

Many of us have believed for decades that this issue has great national security importance. In the 1990s, then-Senator Gore highlighted the issue, and he pushed to keep the issue on the national agenda as Vice President. The Nation then began using intelligence assets and our allies to collect data on climate change. I think this is a little-known fact by people in our country and people around the world. That, of course, came to a halt in 2001. And I think it is really being resurrected today, to move forward and to really accept one of the great challenges of the 21st century.

Outside experts began acknowledging the linkage between the environment and security, and so this hearing today brings the two together with the two committees that have done work on this.

This year, Javier Solana, the E.U. High Representative for Common Foreign and Security Policy, issued a paper calling for coordinated research on mitigation and on coping strategies for global climate change. In 2007, the German Advisory Council on Global Change argued for the importance of stopping climate change trends. The CNA, advised by 11 former generals and admirals, released an in-depth report on likely security implications. And the Center for Security and International Studies and the Center for a New American Security released a joint report on the same.

Last April, after the release of the CNA study, I wrote to the Director of National Intelligence, Mike McConnell, and asked him to undertake a National Intelligence Estimate of the anticipated geopolitical effects of global climate change and the implications of such effects on the national security of the United States. He responded that it would be, quote, "entirely appropriate" for the National Intelligence Council to prepare such an assessment.

But when we included a requirement for a National Intelligence Estimate in the intelligence authorization bill, there actually were those that ridiculed the issue on the floor of the House. I think we are coming a long way today. This report should put those doubts to rest.

I want to salute our witnesses that have done so much work on this issue and the Director of National Intelligence for their work on this assessment. The NIA is the result of just open-source collaboration between the Intelligence Community and the scientific and academic communities.

While I am pleased with the report's conclusions, I am disappointed—and that disappointment is shared by many of my colleagues—that it is classified "confidential." This is the lowest level of classified information, a classification level rarely used, but one that prevents this report from being released and discussed in the public domain.

I have often noted that the Intelligence Community, at least in my view, overrelies on secrecy and classified information. In this instance, I believe that the document should not be classified, and I hope that the DNI will decide to declassify it.

The Intelligence Community accepted the science as a given and without judgment, and still found that there are very serious national security implications. Increased global temperatures mean heavy precipitation events, reduction in glaciers and Arctic ice, and rising sea levels. These climatic events will mean crop failures, water shortages, flooding, coastal storms, and increased incidents of infectious diseases. Each of these leads to instability.

And our witnesses, I believe, are going to talk about this. I am not going to go into the detail of many of them.

I also want to add that as many as 48 U.S. coastal military installations are endangered by flooding and associated damage.

Now, some would claim that by discussing the implications of global climate change we are creating a panic, because, as someone said, no one can predict the weather. In the law enforcement community, in the emergency response community, we train people for the eventuality of things taking place. In other words, we prepare. And so I believe that we must address the foreseeable consequences. And it is the lack of preparedness that should cause any kind of panic.

I would note that in a speech last month, the NATO Secretary General, Jaap de Hoop Scheffer, described the greatest security challenges facing the alliance. And he said the following, and I will close on this: "In tomorrow's uncertain world, we cannot wait for threats to mature before deciding how we counter them. The nature of this new environment is already taking shape. It will be an environment that will be marked by the effects of climate change, such as territorial conflicts, rising food prices, and migration. It

will be characterized by the scramble for energy resources, by the emergence of new powers, and by nonstate actors trying to gain access to deadly technologies."

Note that the very first threat he mentioned are the effects of global climate change. There is no question in his mind that the climate change poses a national security challenge. And I think that, from this day forward, the words "climate change" and "international security" will be forever linked.

So I want to thank everyone for being here, especially the wonderful subcommittee that I have the privilege of chairing.

And I especially want to point out the wonderful and important work of our staff: Diane La Voy, Mieke Eoyang, and Josh Resnick.

And, with that, I will yield back the balance of the time that, really, I don't have. Thank you, Mr. Chairman.

The CHAIRMAN. I thank the gentlelady.

The Chair recognizes the gentleman from Wisconsin, Mr. Sensenbrenner, the ranking member of the Select Committee on Global Warming.

Mr. SENSENBRENNER. Thank you very much, Mr. Chairman.

This is the third hearing on the national security implications of climate change that I have attended since this Congress began. It was the topic of the select committee's first-ever hearing in April 2007, as well as a hearing in the Science Committee last September.

Reading through the testimony, it doesn't seem like there is much new information to assess. Much of the information today is based on last year's U.N. Intergovernmental Panel on Climate Change reports. The conclusions of the IPCC have been studied in great detail by this Congress and warrant further consideration in the next Congress. However, I think the American people want the Congress today to focus on how to reduce gas and energy prices, improve energy security, and to increase domestic energy supplies.

The National Intelligence Estimate appears to give a good overview of climate change projections, how they might affect certain regions and nations, and how this will affect the United States. The NIA constructs these projections out to 2030, which is a far shorter time frame than many of the projections in the IPCC report. Much of the worst-case scenarios projected by the IPCC are in the latter half of this century.

The national security implications of climate change will cause some concerns. But so do the implications of climate change policies that stand to reduce the availability of cheap, reliable energy sources around the world.

Many of the cases detailed in the NIA will have to be dealt with through adaptive measures. As one of our witnesses will point out today, much of the world is not only poor, but energy poor, which makes adaptation much more difficult.

The testimony of Marlo Lewis, senior fellow at the Competitive Enterprise Institute, shows that an estimated 1.6 billion people have no access to electricity at all. Power plants, however fueled, would immeasurably improve these people's lives. Where do they fit into the climate change picture?

The testimony of Lee Lane, resident fellow at the American Enterprise Institute, summarizes the complexity of this issue. Mr.

Lane notes that the lens of national security might not be the best way to view the issues associated with global warming. Climate change policy will require trade-offs that are unavoidable, including a weakened U.S. economy, that could affect how this country handles conflicts.

And Mr. Lane notes that if China and India do not participate in efforts to cut greenhouse gases, worldwide efforts to reduce carbon dioxide concentrations will fail. And I agree. And yet efforts to force China and India into compliance will only worsen global conflicts.

Mr. Lane is also right to point out that the only way to achieve these greenhouse gas reductions is through the development of new technology and that, in the near term, the focus should be on further developing technologies like nuclear, clean coal, solar, wind and biomass. These technologies have the potential to produce clear, tangible improvements to the environment, which must be a key part of any climate change policy.

These technologies can also help bolster the energy security of the United States, which should be a top priority of the Democratic leadership in Congress. There is perhaps no action that could better help the energy security of the United States than providing access to domestic oil and gas supplies. However, instead of taking this crucial action, Congress today will again talk about the threat of global warming, as opposed to the real threats of high energy prices and energy security.

I thank the Chair, and I yield back the balance of my time.

The CHAIRMAN. I thank the gentleman.

And now the Chair recognizes the ranking member of the Intelligence Subcommittee, the gentleman from California, Mr. Issa.

Mr. ISSA. I want to thank Chairman Markey, Madam Chairwoman Eshoo and Ranking Member Sensenbrenner. Additionally, I want to thank Dr. Fingar and our second panel of witnesses for testifying here today.

I come here today with a number of questions and reservations on the recent National Intelligence Assessment on global climate change. Our Nation and its Intelligence Community are facing many serious threats. At a time when we are short on analysts to assist in finding weapons of mass destruction and terrorist activities around the globe, I am concerned that projects like this on climate change and the NIA amount to a dangerous diversion of intelligence resources.

I don't say that lightly. I don't make climate change a light issue. The question is not, is it appropriate for us to be concerned about possible climate change and its impacts? Of course not; that is a great concern. Is it appropriate to ask hypothetical questions to the State Department, to the CIA and others on what will happen if X occurs? All of that is reasonable. We continue to do it, and I would expect, on a bipartisan basis, we continue to ask those questions so that we can plan and so that we know that the community is doing its planning.

What I am concerned about is, clearly, the CIA and other intelligence agencies do not and should not have the resources of climatologists. I believe that that is probably our greatest threat.

I hope today we will look at this in terms of what it is. It is a study of, if in fact there is drought, if in fact there is famine, if in fact a number of things occur. It is not a study of, will they occur. On that, the science is not settled, although the science is unsettling.

Certainly, for all of us who remember a quote—we earlier had quotes—but a quote that goes this way: "I believe it is appropriate to have an overrepresentation of factual presentations on how dangerous it is as a predicate for opening up the audience to listen to what the solutions are." That quote, of course, I have to give credit to Vice President Al Gore.

I could go on and give the quotes on Dr. Hansen, who now is a leading advocate on climate change and, some would say, an alarmist, when, in fact, he was also an author of the "nuclear winter" we were going to receive as of 1971. He was wrong then, and he is wrong now.

That doesn't mean that we shouldn't be concerned about the effects of putting carbon-based fuels into our climate. We should be concerned for a number of reasons: First of all, we don't know the effects. Second of all, the effects we do know include pollution that adversely affects life around the world. Lastly, we know that these are limited resources. In America today, with $135 oil, mostly due to our lack of willingness to produce domestically, we fully understand why our cost is so high, and yet we would like to have it lower.

So I would like to join all of the people on the dais here, I believe, in saying that we have to find alternatives that help drive down the cost of oil, reduce the use of hydrocarbons, and continue the study by serious climate-based professors, none of whom, by definition, would normally be in the CIA, in order to find out the real question of when will these events occur, if they will occur, and how we can stop them.

Lastly, Mr. Chairman, I think the most important thing for us to remember here today is not 7 years ago, not 17 years ago, not 27 years ago, but in 1971, when we began looking at climate and the production of—then it was dust and other particulates, but clearly the effects of burning oil, natural gas, coal, we sounded an alarm. That was at a time in which an answer was open to us, an answer that in my district produces 2,200 megawatts of power, and that was clean-burning nuclear.

Today, in California, we are prohibited from doing any nuclear—zero emissions. We continue to have an argument throughout that entire period while taking away the solution that the French and the European Union and others have sought, which is, while we don't know the effects of burning carbon-based in some areas, we do in others. Knowing that, in fact, it is not good to burn coal and others, from a particulate standpoint, if we could avoid it, knowing that there are over a billion people without electricity around the world, not this committee but this Congress should dedicate itself to quickly freeing up the prohibition on nuclear so that, in fact, we can get off carbon-based electricity in this country, dramatically reducing our carbon footprint, something we can do today. We can do it in a matter of 5 or 6 years. It will do more, by far, than other

things that we are looking at at the present time, or any other thing we are looking at at the present time.

Mr. Chairman, I would ask unanimous consent to have my entire statement put in the record and would like to move on so we can get to our panelists.

I yield back.

The CHAIRMAN. Without objection, so ordered.

That completes the time for opening statements.

Now I recognize Chairwoman Eshoo for the purpose of introducing our first panel of witnesses.

Ms. ESHOO. Thank you, Mr. Chairman.

Now I would like to introduce our very distinguished first panel.

Dr. Thomas Fingar is the deputy director of national intelligence for analysis and chairman of the National Intelligence Council, or the NIC, which provides the President and senior policymakers with intelligence analyses on strategic issues. Analytic reports produced by the NIC have been reviewed and coordinated throughout the Intelligence Community.

Dr. Fingar will describe the approach that the Intelligence Community has used to produce the National Intelligence Assessment, or the NIA, on the security implications of global climate change. And he will present a summary of the Intelligence Community's key observations on the subject.

However, the NIA, as we stated previously, the NIA itself remains classified at the confidential level.

Accompanying Dr. Fingar from the NIC are Dr. Matt Burrows, the NIC's counselor, who has been key in the drafting of the NIA; and Ms. Karen Monaghan, the national intelligence officer for economics, who is responsible for the NIA's analysis of food and other resources, amongst other issues.

I am also very happy to welcome Rolf Mowatt-Larssen, the director of the Office of Intelligence and Counterintelligence in the Department of Energy, which is one of the 16 agencies that make up the Intelligence Community.

So many people think that there is one agency that makes up the Intelligence Community, the CIA. There are 15 others. So he heads up one of the 16 agencies.

This office is responsible for the National Laboratories of the Department of Energy, which will need to play an increasingly important role in assessing and mitigating the security impacts of climate change.

And also of interest is that the office has pursued a collaborative approach in working with other countries on energy and climate as a global security issue, an approach that relies on open-source, unclassified information.

So, Dr. Fingar, we look forward to your prepared statement and to the opportunity to discuss this important topic with you and your colleagues. And we also want to thank you for your very special leadership.

The floor is yours.

STATEMENT OF THOMAS FINGAR, DEPUTY DIRECTOR OF NATIONAL INTELLIGENCE FOR ANALYSIS, CHAIRMAN, NATIONAL INTELLIGENCE COUNCIL; ACCOMPANIED BY ROLF MOWATT-LARSSEN, DIRECTOR, OFFICE OF INTELLIGENCE AND COUNTERINTELLIGENCE, U.S. DEPARTMENT OF ENERGY

Mr. FINGAR. Thank you.

Chairman Markey, Chairwoman Eshoo, members of the committees, thank you for this opportunity to brief your committees on the national security implications of global climate change to 2030.

We have submitted a statement for the record that provides considerable detail on the study and its conclusions. As you requested, I will provide only a brief summary, but I ask that the full statement be included in the record.

The CHAIRMAN. Without objection, it will be included.

Mr. FINGAR. The just-completed National Intelligence Assessment that undergirds our statement for the record was a new and challenging venture for the Intelligence Community.

Our ultimate objective was to assess the national security implications for the United States of global climate change. In order to do so, we had to reach outside the Intelligence Community for expertise on climate science, on how projected changes would affect specific countries. We did not address mitigation, nor make any judgments about costs or future technologies.

The approach we adopted had four stages.

Stage one was to establish a starting point. Since the Intelligence Community does not conduct climate research, we turned to other U.S. Government organizations with the requisite expertise, including the U.S. Climate Change Science Program and climate modelers and experts for the Department of Energy National Laboratories and the National Oceanic and Atmospheric Association.

Our primary source for climate projections was the Intergovernmental Panel on Climate Change fourth assessment report. We relied primarily on the report's mid-range projections.

Stage two was to assess how global climate change projections would impact specific countries. For this stage, we commissioned parallel studies by the Joint Climate Change Research Institute, a collaborative research program of the University of Maryland and the Pacific Northwest National Laboratory, and Columbia University Center for International Earth Science Information Network.

Both teams examined how projected climate change would affect water scarcity, populations at risk from sea-level rise, and overall vulnerability to climate change in approximately 60 countries. The countries examined did not include highly developed countries with the economic, technical and political capacity to cope with the effects of climate change between now and 2030.

The results of stage two were reviewed by country and regional specialists convened by the National Intelligence Council and the Naval Postgraduate School. The goal was to assess the ability of each of the countries and regions to cope with the projected impacts.

The results of the stage three assessment provided the basis for the Intelligence Community's examination of how the results of

projected climate change would affect U.S. national security interests to 2030.

The fourth stage of the study assumed that climate change will occur as forecast by the IPCC report, and that it will affect specific countries as projected in stages two and three.

We chose 2030 as the end point because it is far enough in the future to see physical and biological effects of climate change but close enough to allow judgments about the likely impact of such changes.

I will now summarize briefly the key conclusions of our assessment.

Our analysis found three primary paths through which the effects of climate change could impact national security: water scarcity, decreased agricultural productivity, and infrastructure damage.

Water scarcity and decreased agricultural productivity can trigger human migration. Regardless of whether the migration is inter- or intrastate, it could cause or exacerbate tensions between the migrants and the receiving population.

Damage to infrastructure resulting from increases in the frequency or intensity of severe weather events could have significant economic costs and add to social and political tensions. Social tensions and economic costs could lead to state or regional instability, threatening U.S. interests.

We judged that global climate change will have wide-ranging implications for U.S. national security interests over the next 20 years, because it will aggravate existing problems, such as poverty, social tensions, environmental degradation, ineffectual leadership, and weak political institutions. All of these threaten domestic stability in a number of African, Asian, Central American and Central Asian countries.

We assess that climate change alone is unlikely to trigger state failure in any state during the period to 2030, but it could contribute to inter- and, more likely, intrastate conflicts, particularly over access to increasingly scarce water resources.

We also judge that climate change effects could prompt migration in search of better living conditions, both within nations and from disadvantaged to more affluent countries.

Climate-induced or -exacerbated tensions will be a major contributor to instability in several areas of Africa, where many countries are already challenged by persistent poverty, frequent natural disasters, weak governance, and high dependence on rainfall for agricultural yields.

In Asia, current research indicates that extensive parts of South, Southeast, and East Asia will face risks of decreased agricultural productivity, floods and droughts. By 2025, cereal crop yields would decrease by 2.5 to 10 percent, according to some calculations. Projections indicate that as many as 50 million additional people could be at risk of hunger by 2020.

Most developed nations and countries with rapidly growing economies are likely to fare better than those in the poorer developing world, largely because of greater coping capacity. Nevertheless, many regional states important to the United States could experience negative consequences. Rapidly developing states could ex-

perience economic setbacks and uneven growth, leading to political instability. Most U.S. allies will experience negative consequences, but also have the means to cope with the projected effects of climate change out to 2030.

Some countries will benefit from climate change effects, including those in the Northern Hemisphere, where temperature increases will lengthen growing seasons and facilitate access to energy and other resources. Most of North America in the mid-latitudes will be less affected by climate change in the next few decades than either the tropics or the polar regions. Most studies suggest the United States as a whole will enjoy modest economic benefits from increased crop yields, but the Southwest will have serious water problems, and the East Coast could be subject to more severe weather.

Current infrastructure design criteria and construction codes may be inadequate for climate change, increasing vulnerability to heightened storm intensity and flooding. A number of coastal military installations in the Continental United States are at significant risk of damage from storm surge-induced flooding. Two dozen nuclear facilities and numerous refineries along U.S. coastlines are at risk.

Mr. Chairman, this brief outline presents a summary at the 50,000-foot level, but I hope it has given you a clear understanding of how we conducted the study and the nature of the implications for the United States.

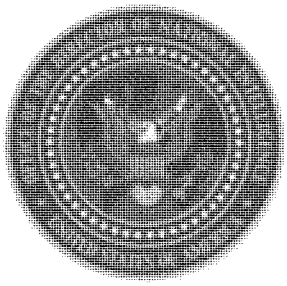
My colleagues and I will now be very happy to provide additional details in response to your questions.

[The statement of Mr. Fingar follows:]

House Permanent Select Committee on Intelligence
House Select Committee on Energy Independence and Global Warming

25 June 2008

National Intelligence Assessment on the National Security Implications of Global Climate Change to 2030



Statement for the Record

of

Dr. Thomas Fingar

Deputy Director of National Intelligence for Analysis and Chairman of the National Intelligence Council

STATEMENT FOR THE RECORD OF
DR. THOMAS FINGAR
DEPUTY DIRECTOR OF NATIONAL INTELLIGENCE FOR
ANALYSIS AND CHAIRMAN OF THE NATIONAL INTELLIGENCE
COUNCIL

BEFORE THE
PERMANENT SELECT COMMITTTEE ON INTELLIGENCE AND THE
SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL
WARMING
HOUSE OF REPRESENTATIVES

25 JUNE 2008

Chairman Markey, Chairwoman Eshoo, Ranking Member Sensenbrenner, Ranking Member Issa, and Members of the Committees thank you for the opportunity to brief both committees on the "National Security Implications of Global Climate Change to 2030." I am Tom Fingar, the Deputy Director of National Intelligence for Analysis; I am joined today by Rolf Mowatt-Larssen – Director, Office of Intelligence and Counterintelligence at the Department of Energy, Dr. Mathew Burrows – the NIC's Counselor, and Ms. Karen Monaghan – the National Intelligence Officer for Economics. I would like to divide my remarks into four sections this afternoon. I will first provide an overview of the history and the process the Intelligence Community (IC) used to explore this topic, followed by a summary of our key observations; and then I will provide a brief description of some of the collection and analysis challenges, and lastly our future plans.

History and Process

We began our effort following a National Intelligence Priorities Framework review in 2006, believing the time was right to develop a

community level product on the national security significance of future climate change. It had obviously become an important global issue. Following draft Congressional language in the Spring of 2007, we elevated the level of our effort to a National Intelligence Assessment (NIA), developed terms of reference, and initiated the study.

This study used a fundamentally different kind of analytical methodology from what is typical for an intelligence product such as a National Intelligence Estimate (NIE). We depended upon open sources and greatly leveraged outside expertise. Since the Intelligence Community does not conduct climate research, we began our effort by looking for other US government entities that were experts in this area. We worked with the US Climate Change Science Program and visited with climate modelers and experts from the Department of Energy national laboratories and the National Oceanic and Atmospheric Agency (NOAA). We also relied upon support from the Joint Global Change Research Institute—a joint research program between the University of Maryland and the Pacific Northwest National Laboratory—Columbia University's Center for International Earth Science Information Network, and the Naval Postgraduate School in Monterey California.

Our primary source for climate science was the United Nations Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, which we augmented with other peer-reviewed analyses and contracted research. We used the UN Panel report as our baseline because this document was reviewed and coordinated on by the US government and internationally respected by the scientific community. For this analysis, we

relied predominately upon a mid-range projection from among a range of authoritative scenario trajectories provided by the IPCC.

Our overall strategy consisted of developing a good understanding of climate science, and supplementing this with state specific information on water scarcity, overall vulnerability to climate change, and populations at risk of sea level rise. In consultation with the Naval Postgraduate School, we analyzed this material to assess the capability of specific nation-states to cope with the effects of climate change. We did not evaluate the science of climate change per se; nor did we independently analyze what the underlying drivers of climate change are or to what degree climate change will occur.

Throughout our effort, we remained mindful of what the effects of future climate change would mean for US national security. We used a broad definition for national security. We first considered if the effects would directly impact the US homeland, a US economic partner, or a US ally. We also focused on the potential for humanitarian disaster, such that the response would consume US resources. We then considered if the result would degrade or enhance one of the elements of national power (Geopolitical, Military, Economic, or Social Cohesion), and if the degradation or enhancement, even if temporary, would be significant. In the end, we reported on key effects that we judged would meet this threshold.

The NIA focuses on the implications of global climate change for US national security interests by 2030. In the study, we assume that the climate will change as forecast by the IPCC. The year 2030 is far enough out to have witnessed climate-induced changes to the physical and biological worlds, yet close enough to allow judgments about the likely impact of such

changes. We offer a glimpse of climate change impact beyond 2030 because expectations about the relative severity of climate changes projected later in the century will color the perceptions of policymakers between now and 2030.

On the National Intelligence Council this effort was conducted by the National Intelligence Officers for Science and Technology, and for Economics, and the NIC's Long Range Analysis Unit. Within the Intelligence Community, we were supported by the Defense Intelligence Agency's Armed Forces Medical Intelligence Center, the Office of Naval Intelligence, the Department of State Bureau of Intelligence and Research, the Office of Transnational Issues from the Central Intelligence Agency, and the National Geospatial-Intelligence Agency. We received inputs to the document and critiques from outside experts and allied partners. We used contract studies, previous research, and consultations with many others.

Summary of Key Observations

Allow me to provide a summary of our key observations. We judge global climate change will have wide-ranging implications for US national security interests over the next 20 years. Although the United States will be less affected and is better equipped than most nations to deal with climate change, and may even see a benefit owing to increases in agriculture productivity, infrastructure repair and replacement will be costly. We judge that the most significant impact for the United States will be indirect and result from climate-driven effects on many other countries and their potential to seriously affect US national security interests. We assess that climate change alone is unlikely to trigger state failure in any state out to 2030, but the impacts will worsen existing problems—such as poverty,

social tensions, environmental degradation, ineffectual leadership, and weak political institutions. Climate change could threaten domestic stability in some states, potentially contributing to intra- or, less likely, interstate conflict, particularly over access to increasingly scarce water resources. We judge that economic migrants will perceive additional reasons to migrate because of harsh climates, both within nations and from disadvantaged to richer countries.

Climate Change...

Looking more specifically at the future global climate, current scientific observations indicate the Earth's climate is changing. Changes cited by the IPCC include rising global temperatures, increasing heavy precipitation events, and rising sea levels. The global mean annual average temperature has risen 0.13 degrees Celsius (C) per decade during the period 1955-2005—double the rate observed in 1906-2005. However, temperature changes vary across the planet, and impacts vary as a function of local circumstances. Some areas are experiencing less warming or even cooling. Precipitation has generally increased over land north of 30 degrees latitude over the period 1900 to 2005, but the tropics have experienced less precipitation since the 1970s. IPCC says that intense tropical cyclone activity is likely to increase. Global sea level rose 1.7 mm per year during most of the 20th century, but has risen approximately 3 mm per year since 1993.

Many physical and biological systems are changing in ways consistent with the present warming trend. Among the most significant changes

highlighted by scientists are the thawing of the northern latitude permafrost[1] which is forcing repair or replacement of buildings and pipeline infrastructure, and the increase of heat waves and droughts (both in frequency and intensity), although attribution of increased droughts to greenhouse gas (GHG) emissions remains controversial.

In some cases, changes in ecosystems and natural resources are occurring faster and with larger magnitude than scientists anticipated as recently as ten years ago. Temperatures in the Arctic are rising almost twice as fast as the global rate, and temperatures are rising faster over land masses than over open oceans.

Looking out to 2030, certain broad-brush projections of climate change can be made. Global temperature change is expected to increase approximately one half degree C over the next two decades and sea level rise is expected to be no greater than 75mm (.075m).[2] The IPCC and others project that water will become increasingly scarce across several regions, including parts of Asia and parts of Africa and the southwestern United States. Water scarcity can be caused by many factors—absence of precipitation, increased evaporation, demographics, land use, or reductions in river flows.

...And National Security

From a national security perspective, climate change has the potential to affect lives (for example, through food and water shortages, increased health problems including the spread of disease, and increased potential for conflict), property (for example through ground subsidence, flooding,

[1] Permafrost is soil, rock, sediment or other material with a temperature that has remained below zero degrees centigrade for two or more consecutive years.
[2] The change is reference to the average global temperature for the period 1980 to 1999.

coastal erosion, and extreme weather events), and other security interests. The United States depends on a smooth-functioning international system ensuring the flow of trade and market access to critical raw materials such as oil and gas, and security for its allies and partners. Climate change and climate change policies could affect all of these—domestic stability in a number of key states, the opening of new sea lanes and access to raw materials, and the global economy more broadly—with significant geopolitical consequences.

In addition, anticipated impacts to the Homeland—including possible increases in the severity of storms in the Gulf, increased demand for energy resources, disruptions in US and Arctic infrastructure, and increases in immigration from resource-scarce regions of the world—are expected to be costly. Government, business, and public efforts to develop mitigation and adaptation strategies to deal with climate change—from policies to reduce greenhouse gasses to plans to reduce exposure to climate change or capitalize on potential impacts—may affect US national security interests even more than the physical impacts of climate change itself.

Regional Climate Trends to 2030 [3]

I will now summarize some regional climate change trends.

Africa [4]

Climate-induced tensions are a main contributor to instability in

[3] While the NIA is based predominately upon a midrange scenario, some of the analysis cited in this section refers to IPCC reports with multiple scenarios. However, scientists indicate that even if humans stopped releasing CO2 tomorrow, climate changes projected for 2030 would still occur. Scenario trajectories—including those emphasizing concerted emissions reductions—do not vary significantly over the next 20-25 years. Not all IPCC or peer-reviewed research is targeted to the 2030 time frame of this assessment. Therefore when the targeted research reflects a different period of time we specifically mention the targeted time period.

[4] Regions are listed in alphabetical order.

several areas of Africa. We judge that sub-Saharan Africa will continue to be the most vulnerable region to climate change because of multiple environmental, economic, political, and social stresses. Observed temperatures have become warmer since the 1960s. This has been true across the varied climates of Africa. In addition, from 1961-2000 the number of warm spells increased over southern and western Africa. Rainfall varies a good deal over most of Africa, but increased seasonal variability has been observed since 1970, with higher rainfall anomalies and more intense and widespread droughts.

Scientific studies indicate that climate change is likely to cause agricultural losses, possibly severe in the Sahel, West Africa, and southern Africa. Agricultural yields from some rainfall dependant crops could be reduced by up to 50 percent by 2020.

Many African countries already challenged by persistent poverty, frequent natural disasters, weak governance, and high dependence on agriculture probably will face a significantly higher exposure to water stress owing to climate change.

Asia

In Asia, despite future climate change that is expected to produce increased precipitation, current research indicates that South, Southeast, and East Asia will face risks of reduced agricultural productivity as large parts of the region face increased risk of floods and droughts. By 2025, cereal crop yields will decrease 2.5-10 percent, according to some calculations.[5]

[5] This assumes no CO2 fertilization. Most plants growing in normal atmospheric CO2 exhibit higher rates of photosynthesis and elevated CO2 alone tends to increase growth and yield of most agriculture plants. Most of the studies have been conducted either under controlled environmental conditions (chambers), or under optimal field conditions. Potential CO2 effects on plant biomass depend on the nutrient and water

Observed increases in surface air temperature in recent decades range from less than 1 to 3 degrees C per decade, with the most pronounced warming in north Asia. Annual average rainfall has decreased in Russia, northeast and north China, coastal belts and arid plains of Pakistan, parts of northeast India, Indonesia, Philippines, and some areas of Japan; it has increased in western and southeastern coastal China, Bangladesh, and the western coasts of the Philippines. In parts of Asia extreme weather events[6] are more frequent and severe and intense rains and floods come more often. Droughts have intensified and/or affected more areas in Central, South and Southeast Asia. Tropical storms are more frequent in the South China Sea, and the Bay of Bengal is experiencing fewer but more intense storms.

Some projections indicate as many as 50 million additional people could be at risk of hunger by 2020, although climate change may moderate water stress in some regions of Asia. By the 2020s increases in precipitation and glacier run-off will relieve some of the water stress in Asia, but increasing consumption patterns and growing populations indicate that 120 million to 1.2 billion people will continue to experience some water stress.

Australia and New Zealand

Australia and New Zealand will likely see increased temperature by 2030 and continued changes in precipitation patterns. Since 1950 there has been a 0.3 to 0.7 degrees C warming in the region, with more heat waves, fewer frosts, and an increase in the intensity of Australian droughts. Recent reports indicate more rain in northwestern Australia and southwestern New

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levels. With CO2 fertilization, the Asian cereal crop yields will vary from +2.5 to –10 percent, with China and Mongolia showing the slight rise in one of three data runs.

[6] The IPCC defines an extreme weather event as an event that is rare within its statistical reference distribution at a particular place. Definitions of "rare" vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile.

Zealand, and less rain in southern and eastern Australia and northeastern New Zealand.

According to scientific research, floods, landslides, droughts and storm surges are likely to become more frequent and intense, and snow and frost are likely to become less frequent. Infrastructure design criteria[7] for extreme events, here as elsewhere, are likely to be exceeded more frequently.

Europe

In the coming years, Europe will likely become hotter—with more frequent and severe heat waves—and there will be greater differences in regional precipitation. Europe warmed 0.90 degrees C between 1901 and 2005. However, the rate of warming has accelerated since 1979. During this latter period, the rate was higher in central and northeastern Europe and in mountainous regions but lower in the Mediterranean regions. Precipitation change varies in different areas of Europe. Average winter precipitation is increasing in most of Atlantic and northern Europe, while yearly precipitation trends are decreasing in eastern Mediterranean regions. Most parts of the continent are receiving more precipitation per wet day, even in some areas that are becoming drier.

By the 2020s, increases in winter floods are likely in maritime regions and more flash floods are likely throughout Europe.

Latin America and the Caribbean

By 2020, temperature increases in Latin America will vary across the region, with the highest temperatures projected to occur over tropical South America. Temperature increases are likely to increase from 0.4 to 1.8

[7] Infrastructure design criteria include such things as maximum and minimum temperature, rates of precipitation, snow and ice accumulation, and wind intensity and direction.

degrees C over the 1980-1999 period. Highly unusual extreme weather events have occurred in some areas of South America including intense rainfall, flooding, drought, hailstorms, and the unprecedented Hurricane Catarina in the South Atlantic. In addition, the Caribbean Basin experienced a record hurricane season in 2005. Increases in rainfall in selected regions of South America have affected land use and crop yields, and increased flood frequency and intensity. Precipitation has decreased in other regions including western Central America.

Latin America may experience increased precipitation by the 2020s; by some estimates tens of millions of people could be removed from water stress in considering only the effects of climate change. However, despite the greater water availability from climate change, an estimated 7-77 million people are likely to remain stressed due to growing populations and increasing water consumption.

Middle East [8]

Prospects for the Middle East are harder to anticipate because of limited climate research. By 2020 the region is expected to see an increased temperature of slightly over one degree C. Precipitation is expected to decrease between 3 and 8 percent in winter and spring, and increase 5 to 18 percent in summer and fall.[9] From 1951 to 2003, several stations in different climatological zones of Iran reported significant decreases in frost days due to a rise in surface temperatures.

Surface water availability from major rivers like the Euphrates and Tigris may be affected by future alterations in river flows. River flows are

[8] The Middle East is not an IPCC region, but is generally reflected in research and reporting as the West Asia sub-region.
[9] Changes expressed are relative to 1980-1999 values.

likely to increase in winter and decrease in spring, which could negatively affect existing uses of river water.

North America

Most of North America in the mid-latitudes will likely be less affected by climate change in the next few decades than either the tropics or the polar regions. Net cereal crop yields likely will increase by 5-20 percent,[10] for example, and most studies suggest the United States as a whole will enjoy modest economic benefits over the next few decades largely due to the increased crop yields. Costs begin to mount thereafter, however, and some parts of the United States—particularly built-up coastal areas—will be at greater risk of extreme weather events and potentially high costs related to losses in complex infrastructure. From 1955 to 2005, annual mean air temperature increased to the greatest extent in Alaska and northwestern Canada, followed by the continental interior. The growing season has lengthened an average of two days per decade since 1950 in Canada and the contiguous United States.

For most of North America, annual precipitation has increased, with the most marked increase in northern Canada. However, precipitation has decreased in the southwest United States, the Canadian prairies, and the eastern Arctic.

Polar Regions

Scientists state that the polar regions, which are already affected by climate change, will see further change by 2030 to include loss of land- and sea-based ice and greater exposure of bare ground. For several decades,

[10] The increase assumes CO2 fertilization. Without CO2 fertilization, the range is –2.5 to + 10 percent change in cereal yields, with the poorer yields in Mexico and to a lesser extent, the United States (two of three data runs).

surface temperatures in the Arctic have warmed about twice as fast as the global rate, with associated reductions of sea ice and glaciers. In addition, the duration of river and lake ice has decreased in northern latitudes, and (since 1980) permafrost has warmed in nearly all areas for which measurements are available. Evidence reported in the IPCC Fourth Assessment Report indicates that the Greenland ice sheet's interior is thickening at a decreasing rate while its edges are thinning. The Antarctic shows more variability; meteorological stations show strong and significant warming over the past 50 years, but other long-term records are mixed.

Economic Impacts Projected to Rise Over Time

We assess that no country will be immune to the effects of climate change, but some will be able to cope more effectively than others. Most of the struggling and poor states that will suffer adverse impacts to their potential and economic security are in Sub-Saharan Africa, the Middle East, and Central and Southeast Asia. However, the spillover—from potentially increased migration and water-related disputes—could have a harmful global impact. The global impact on economic growth out to 2030 or so is likely to be minimal, but the effect in particular countries or regions could be substantial.

Most estimates—including the UK commissioned Stern Review—show limited aggregate damage to the world economy by the 2030s. One model, for example shows a decline of 0.3 percent annually of global GDP by 2030. A couple of economic models yield net benefits for OECD and other countries with small increases in global mean temperature—the most likely scenario in the next decade or two. However, the impact on global economic growth begins to mount over time and even conservative estimates

put the costs at up to 3 percent of global GDP annually if the Earth's temperature were to rise 2-3 degrees C, which many scientists believe could begin to happen as early as mid-century.

Agricultural Production Most at Risk

Global cereal yields likely will increase out to 2030, but regional differences in production are likely to grow stronger over time with declines proportionately concentrated in developing countries, particularly in Sub-Saharan Africa. Although the precise impact of climate change on agriculture production will differ by region and crop, damages broadly speaking will be greater in countries located closer to the equator and where temperatures are higher today. For many developing countries, reduced agriculture output can be devastating as agriculture represents a large share of their economy, a majority of their populations rely on subsistence farming, and their governments and people have less adaptive capacity.

International Migration

We judge that economic refugees will perceive additional reasons to flee their homes because of harsher climates. Besides movement within countries, especially to urban areas, many displaced persons will move into neighboring developing countries, sometimes as a staging ground for subsequent movement onward to more developed and richer countries with greater economic opportunities. Many likely receiving nations will have neither the resources nor interest to host these climate migrants. Receiving nations probably will have increased concern about migrants who may be exposed to or are carrying infectious diseases that may put host nation populations at higher risk.

Winners and Losers from Climate Change

Most developed nations and countries with rapidly emerging economies are likely to fare better than those in the poorer, developing world, largely because of a greater coping capacity. Nevertheless, many regional states important to the United States will be negatively impacted. Rapidly developing states could experience economic setbacks and uneven growth leading to political change or disruption. And most US allies will experience negative impacts but also have the means to cope.

Implications for the United States

On the homefront, responding to thawing in and around Alaska, water shortages in the Southwest, and storm surges on the East and Gulf Coasts will involve costly repairs, upgrades, and modifications. A warming climate also will encourage wildfires throughout the longer summers. The IPCC estimates annual costs from severe weather in damage to property and loss of economic productivity for the United States to be in the tens of billions of dollars. Nonetheless, most models predict that the United States on balance will benefit slightly from climate change over the next few decades, largely due to increased agricultural yields. Current infrastructure design criteria and construction codes may be inadequate for climate change and exacerbate vulnerability to increasing storm intensity and flooding. A number of active coastal military installations in the continental United States are at a significant and increasing risk of damage, as a function of flooding from worsened storm surges in the near-term. In addition, two dozen nuclear facilities and numerous refineries along US coastlines are at risk and may be severely impacted by storms.

The United States' new military area of responsibility—Africa Command—is likely to face extensive and novel operational requirements. Sub-Saharan African countries—if they are hard hit by climate impacts—will be more susceptible to worsening disease exposure. Food insecurity, for reasons both of shortages and affordability, will be a growing concern in Africa as well as other parts of the world. Without food aid, the region will likely face higher levels of instability—particularly violent ethnic clashes over land ownership.

Closer to home, the United States will need to anticipate and plan for growing immigration pressures. Although sea level rise is probably a slow and long-term development, extreme weather events and growing evidence of inundation will motivate many to move sooner rather than later. Almost one-fourth of the countries with the greatest percentage of population in low-elevation coastal zones are in the Caribbean, so assisting these populations will be an imminent task. Broad Western hemispheric cooperation will be necessary to mitigate the impact on harder-hit countries.

As climate changes spur more humanitarian emergencies, the international community's capacity to respond will be increasingly strained. The United States, in particular will be called upon to respond. The demands of these potential humanitarian responses may significantly tax US military transportation and support force structures, resulting in a strained readiness posture and decreased strategic depth for combat operations.

To insert a sense of urgency into the debate and pressure international institutions and countries to adopt adaptation and mitigation strategies, environmental and human rights NGOs may press to broaden the definition of "refugee" to include environment or climate migrants. Such a change

would have implications for the United States, other donors, and organizations like UNHCR to provide assistance to displaced populations similar to recent efforts to provide aid to internally displaced peoples. Elsewhere, developing countries—particularly major greenhouse gas emitters—may demand that the WTO Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS) be amended to allow for the production and development of generic copies of green technologies, citing the precedent of HIV AIDS drugs. Indeed, last year the European Parliament asked for an examination of whether TRIPS presented a significant barrier to technology transfer.

In multinational forums, we assess that the climate change issue will become more prominent on the agenda, and the US's leadership overall in the global arena will be judged by the extent to which it is perceived as forging a viable and effective global consensus for tackling climate change. Expectations are that US leadership will be pivotal in helping the international community set meaningful long-term goals for greenhouse gas emissions reductions and mitigating and adapting to climate change through technological progress and transfers, financial assistance, and support for climate migrants.

Collection and Analysis Challenges

Let me now discuss collection and analytic challenges we faced in the development of this assessment. As I indicated in my opening remarks, we used a fundamentally different type of collection and analytic methodology and were fortunate to have assistance from talented expertise inside and outside of the Intelligence Community.

To answer the question of national security impacts from Global Climate Change, we needed first and foremost to understand what the future climate might look like and what the physical and ecosystem impacts of change might be. For this, we were critically dependant upon open source science and, as I indicated, elected to use the IPCC reports and other peer-reviewed scientific material. From an intelligence perspective, the present level of scientific understanding of future climate change lacks the resolution and specificity we would like for detailed analysis at the state level. Most of the IPCC material is based upon an understanding of how the climate may change at the global level. We require improved and better validated regional and local models (accounting for regional and local processes) of strategic climate change, particularly models that provide details on hydrological consequences and changes in the frequency and intensity of extreme events.

Finally, there is a need for better information on physical, agricultural, economic, social, and political impacts from climate change at state and regional levels. This research does not necessarily require classified sources or methods and may be performed in an open and unclassified environment. From an IC perspective we do not seek to duplicate capability that exists in the open scientific community, but we will benefit from continued support for research to resolve the above issues.

From an analytical perspective, the IC examines state stability as a critical part of determining potential threats to US interests. When evaluating state stability, water shortages, disease, and the environment are considered along with other factors. The IC also considers the effects that climate change negotiations and mitigation efforts will have on the US

economy, its trade goals, and its diplomatic relationships with the international community.

Near term, additional analysis is required to determine the world-wide potential vulnerability to storm tracks and severe weather. This analysis should consider changes in anticipated storm tracks and severe weather patterns, populations and infrastructure at risk, and local physical factors. In addition, detailed agriculture vulnerability should be studied; this would include anticipated changes in temperature, precipitation levels and patterns. Much, if not all, of this analysis can be performed with open source data, and much of the basic analytical work can be performed outside of the Intelligence Community by academia or non-IC components of the US Government.

Our analysis could be greatly improved if we had a much better understanding and explanation of past and current human behavior. Continued research to model social human dynamics at the individual and society level would support this improved understanding. This would necessitate the ability to integrate social, economic (infrastructure, agriculture, and manufacturing), military, and political models. Continued research in these efforts—while a significant challenge—could have high analytical payoff. In the interim, assessing the future of a society's evolution will by necessity be a scenario-driven exercise and an imprecise science. The continued use of outside experts is critical to our success.

Future Research Plans

I would like to conclude with a summary of our tentative plans for future work. The National Intelligence Council plans on three follow-on

efforts. As I alluded to earlier, we were challenged in the present effort to get detail information on specific states. However, the science of modeling is continuously improving and we believe that more focused and targeted studies can be of value today. For one effort, we would like to explore in depth the potential effects of climate change on a set of countries and regions of the world and the resulting impact to US security interests.

For the second effort, we would like to conduct a scenario exercise and report on the potential national security impacts from possible climate change remediation strategies. We call this type of work "alternative analysis." We recognize that global remediation efforts will most likely come from a wide variety of sources and that the final determination of what strategies a state chooses will be dependant upon many factors aside from national security. Our objective with this effort is to better inform the policy community as to the national security ramifications from each of these strategies. At present the four remediation strategies we are considering include a predominant dependence upon either carbon capture and sequestration, biofuels, a family of renewables, or nuclear power.

Our third effort will be to explore the geopolitics of climate change and how that may shift the relationships between major powers. Some of this will also be explored in the NIC's Global Trends out to 2025, which is expected to be published in December 2008.

The CHAIRMAN. Thank you so much, Dr. Fingar.

And I want to congratulate you, first of all, on the National Intelligence Assessment. It is a first-class product. Our Nation is indebted to you and your team. You have done a very good job here in laying out this problem for our country and for the planet. And I think it has already had a major impact on the debate about how this country must act aggressively to combat the threat of global warming.

In your testimony, you conclude that global warming will multiply existing problems internationally, including social tension, environmental degradation, ineffectual leadership, weak political institutions, poverty, scarcity of resources, and large-scale migration. That, to me, sounds like a laundry list of the underlying causes of terrorism.

Could global warming worsen the very problems that are underlying and driving the terrorism problem today?

Mr. FINGAR. First of all, thank you for the positive comments on the National Intelligence Assessment. I will certainly pass them to the people that did most of the heavy lifting on this project.

The summary of conditions that you provided and that is in our statement is very similar to the list of conditions and preconditions for alienation that appear to be at work in some cases of recruitment into terrorist activity. So I think logic suggests that the conditions exacerbated by the effects of climate change would increase the pool of potential recruits into terrorist activity.

The CHAIRMAN. And from your perspective, is this additional contribution to terrorism something that the United States should be concerned about and take action to prevent?

Mr. FINGAR. We should certainly be concerned about any factors, any instance, any areas in which recruitment of people to terrorist activities is occurring. So my short answer would be yes.

The CHAIRMAN. As you look at Somalia and Darfur, do you believe that those were areas where this did actually contribute to the rise in tension amongst different groups and, as a result, increase the national security concerns of the United States?

Mr. FINGAR. If you are drawing the linkage from drought here as a climate-change-exacerbated factor, drought is certainly one of the factors in the unstable situation in Sudan, in Darfur, but only one of those. The clashes that are partly religious, partly ethnic, partly economic, partly the strivings of people for the ability to live in a very difficult situation—all are a factor in creating a terrible humanitarian situation.

To my knowledge, we have not had instances of large-scale recruitment or attempts to recruit for terrorist activity out of this particular population.

The CHAIRMAN. You mentioned that the Intelligence Community has done very little work on assessing the implications of climate mitigation strategies, whether they are carbon capture and sequestration, biofuels or nuclear.

I really don't understand the conclusion drawn on page 7 of your testimony that, quote, "Efforts to develop mitigation and adaptation strategies to deal with climate change may affect U.S. national security interests even more than the physical impacts of climate change itself."

If we haven't analyzed mitigation strategies yet, where does the conclusion that doing the work to avoid global warming would be even worse than global warming itself? Is that sentence from page 7 in the classified National Intelligence Assessment, or was this added to your testimony at some later point?

Mr. FINGAR. No, it is a part of the reason that we have planned follow-on studies to look at mitigation effects.

The operative word is "may." We don't know. We don't know what effects efforts to expand nuclear power will have on proliferation possibilities. We don't know what effect mitigation efforts in one country may have on conditions in a second or a third country; that, for example, mitigation effects in India that could affect, perhaps adversely, conditions in Pakistan.

So that is the reason the sentence is there. We think it is important to take proposed remediation activities and look at them so that we can provide judgments that we cannot make at this time.

The CHAIRMAN. But if we read that conclusion on page 7, you get a totally flawed and false view of what the NIA, which is a hugely important document, actually concluded.

I have seen the classified document. And this idea that our attempts to avoid global warming could be more damaging to U.S. national security than global warming itself is simply not there.

We have seen this administration politicize intelligence before, and it looks like they have done it here again—not you, sir, of course—by inserting in your testimony this statement that is simply not supported by the intelligence and which is, in fact, completely misleading. Clearly, we need to have the NIA declassified in full so that it can be read and debated without being filtered through the White House.

If this White House wants to debate how we should address and mitigate the climate crisis, we welcome that debate. Because it is the White House, not the Congress, that wants to send nuclear power reactors to Saudi Arabia, in the most unstable region in the world, in the name of global warming. There will, I guarantee you, be a severe security implication for this country in the form of uncontrolled nuclear proliferation from that absurd policy.

So I think it is important for us to have it out on the table, if sending nuclear power plants to Saudi Arabia is the administration's argument that they are making in a climate change context.

Again, I thank all of you at the table.

Mr. FINGAR. If I may respond briefly, Mr. Chairman, for the record, to note that the White House had no involvement in the production of either the National Intelligence Assessment or the statement for the record, other than the statement for the record with the normal OMB review process. This is the judgment of the Intelligence Community.

The CHAIRMAN. Did OMB ask for any changes in the language of your testimony?

Mr. FINGAR. Not in that portion of it.

The CHAIRMAN. Let me turn then and recognize the ranking member of the select committee, the gentleman from Wisconsin.

Mr. SENSENBRENNER. I thank you very much, Mr. Chairman.

Dr. Fingar, am I correct in assuming that the National Intelligence Estimate was based exclusively on the report of the Intergovernmental Panel on Climate Change?

Mr. FINGAR. No, sir, you are not correct in that.

Mr. SENSENBRENNER. Okay.

Mr. FINGAR. We took, as a starting point, the IPCC fourth report. We added to that peer-reviewed scientific materials produced in the years since that report was produced. We consulted with a variety of U.S. Government and academic specialists on it. But we did not attempt to evaluate the climate science, that that review and supplementing of it said that reflected a reasonable scientific projection.

The IPCC report is at a global level, which doesn't provide very much useful information on how individual nations, subcomponents of nations, sectors of the economy, agricultural crops and so forth. For that kind of detail, we turned to the two commissioned studies.

Mr. SENSENBRENNER. Several weeks ago, there was an article that appeared in Nature magazine that said, for approximately the next decade, we will be experiencing a period of global cooling.

Was any of the information in the Nature article put into the National Intelligence Assessment, or did that article come out too late for it to be of use to you?

Mr. BURROWS. I don't believe we used it, other than the experts we have consulted may have seen it and factored it into their analysis. But we did not use it.

Mr. SENSENBRENNER. Well, given the fact that the computerized projections that the IPCC used would come up with a significantly different result if even there was a tenth-of-a-degree cooling or a tenth-of-a-degree warming, and greater than that if the variations were different either up or down, how would the National Intelligence Assessment change if the IPCC projections ended up being proven wrong because of changes in actual, observed temperatures either upwards or downwards?

Mr. FINGAR. We can't answer that question, sir——

Mr. SENSENBRENNER. Okay.

Mr. FINGAR [continuing]. Because we took, as the starting point, projected change. If change occurs in ways that are different, then our assessments based on the projection of the individual countries and then a projection of the coping capacity of those countries and then on national security would have to change.

But, again, the starting point for this was the climate science report of the IPCC. They have been peer-reviewed, including in parts of the U.S. Government. If that is wrong, then what follows is wrong.

Mr. SENSENBRENNER. Okay. Well, I think that makes the point that many of us on this side of the aisle are making, is that even a small error on the part of the IPCC projections, compared to what is actually observed now and in the future, is going to make all of this debate really irrelevant, in terms of how we deal with the issue.

I think we are going to be hearing pretty soon that many of the people who have been involved in this effort for quite a while were predicting a nuclear winter and global cooling as late as 25 to 30 years ago. And, in terms of making decisions that would have a

major impact on our economy, one that would weaken our economy at a time when it is not too strong, it seems to me that we ought to stop and think through things. Because if we make decisions now and it is based on imprecise data or projections that are wrong, there will be a lot of people hurt very unnecessarily.

I yield back the balance of my time.

The CHAIRMAN. I thank the gentleman.

And the Chair recognizes the gentlelady, the Chair of the Intelligence Subcommittee.

Ms. ESHOO. Thank you, Mr. Chairman.

First, Dr. Fingar, thank you for your testimony and the written testimony that all of the members have in their binders and have read.

I think that the early questions so far really are indicative and point out, you know, the two different pictures that are painted of the whole issue of climate change, that there were scientists that did great work decades ago and, based on what they knew then, made projections. Now it is being said that, "Gee, they made projections and they got into something and they weren't exactly right, so this is not a sure science, and so let's set this aside and let's do something else." I don't belong to that school of thought.

And I say this with sincerity, because I really respect the ranking member of the select committee, Mr. Sensenbrenner. He was part of the congressional delegation that the Speaker led on climate change to India and, you know, was a real asset to that effort.

I think it is important to lay down once again that the Intelligence Community are not the researchers of the science. They have accepted the science that has been put forward by a variety of agencies and experts, and have moved out to make their comments as a result of their study and the NIC, producing the NIA on the whole issue of how this impacts not only our national security but how it brings about international insecurities.

So, now, my question to you is quite a broad one, and that is: What, in your view, comes next? Should there be a team that is put together in our Intelligence Community?

It seems to me that we cannot and have not been able to do effective work, our own Intelligence Community, without working with other intelligence communities around the world. We strengthen our own ranks and our own efforts and certainly bring a great deal to theirs and the international bodies that I lifted some quotes from their leaders from in my opening statement.

So can you give us your view of what you believe are the next steps that need to be taken? And what mechanisms? What mechanisms do you think exist today, or do we need to design new ones? So that is my question.

Thank you, again, for your superb work.

Mr. FINGAR. Thank you. Thank you for your confidence in asking such an ambitious question.

Additional work clearly is required on climate science. In my judgment, that work is best done in other agencies of the United States government other than the Intelligence Community where the expertise and the access, the contacts with international scientists, counterparts, research institutions around the globe, since this is a global problem, involving existing international mecha-

nisms to continue to work the climate science issues. That climate change issue on which intelligence, covertly, clandestinely acquired information, is not very helpful.

We can't steal Mother Nature's intentions. I am being a little facetious, but the fact of the matter is we don't have a body of classified information that would be significant in size and certainly not different in kind to that which is available in other places.

Where we plan to focus next within the Intelligence Community, based on what we have learned out of the study just completed, is to drill deeper into the effects on individual countries. One of the things that we discovered in doing this study is that for much of the world data doesn't exist with a granularity that is really needed to make confident assessments. So an effort needs to be made to acquire that data. We are going to drill down in selected countries.

A second focus will be a look at the great power implications of the climate change's effects forecast here. Russia——

Ms. ESHOO. Great powers.

Mr. FINGAR. Russia perhaps benefiting, the United States benefiting but having some deleterious impacts. China and India are in the countries that will now experience, over the timeframe——

Ms. ESHOO. In other words, there are winners and losers, a combination.

Mr. FINGAR. There are winners and losers in this; and some of them are very big, important global players. What are the implications for cooperation, for competition for resources and the like? That is a subject for future study.

Ms. ESHOO. Thank you.

The CHAIRMAN. The gentlelady's time has expired.

Mr. FINGAR. The third area would look at some of the mitigation strategies that have been proposed. We didn't do it the first time, but we have been asking how would that change things.

The CHAIRMAN. I thank the gentlelady.

The Chair recognizes the gentleman from California, Mr. Issa.

Mr. ISSA. Thank you, Mr. Chairman.

Let me ask a question, in a little bit of the abstract but not too much.

If I was to say that there were ominous signs that the earth's weather patterns have begun to change dramatically and that these changes portend a drastic decline in food production for serious political implications for just about every nation on earth, the drop in food output could begin quite soon and, perhaps, in only 10 years from now, the regions of decline that would feel the greatest impact would be the wheat production of Canada and Russia, but, additionally, areas on the margin and only marginally self-sufficient, tropical areas in Indonesia, Pakistan, Bangladesh, and Africa, where growing seasons depend on rains brought by the monsoon, would you say that that was at least, in part, essentially what we painted for you with this global climate change as a potential that you had to deal with in your analysis?

Dr. Fingar, I mean, I know that is not the exact words of any of the studies, but isn't that essentially what we painted for you, is that global climate change to begin in as little as 10 years, going

out to 2030, would have these kinds of effects in many of the areas I named?

Mr. FINGAR. I guess three comments.

One is, we took, as a starting point, a set of projections. We took the mid-range projections, which——

Mr. ISSA. I appreciate that on the study, Doctor.

Mr. FINGAR [continuing]. Which are not as extreme as was done there, but that our starting point was a set of projections and scenarios about how climate change would affect the physical and the biological world.

Mr. ISSA. I appreciate that. But, as you said, you are not a climatologist. You don't have them on staff. You had to reach out to get even what the projections were.

What I read you was, as far as I can tell, similar to what you are dealing with as the hypothetical: Change beginning in as little as 10 years, droughts, marginal areas not being able to meet food demands. True or false?

Mr. FINGAR. Well, what I am having difficulty with is the word "hypothetical."

Mr. ISSA. Well, let me be less hypothetical.

You were—between your graduate and undergraduate years in 1975, I think you were a Ph.D. candidate when that was written. That was based on global cooling.

The projections for global cooling, Newsweek, Science, full page, 1975, were that those things would occur, that marginal areas, areas having less technology, less able to cope with, such as Indochina then, the Soviet Union, Canada, based on their wheat, because wheat harvests don't do very well as it warmed in that case, and certainly the areas along the Equator, if they stop getting the rain that came with monsoons, that that would adversely affect and lead to instability. Now, your study today, based on the opposite, or the studies you accepted based on the opposite, have the same effect.

My point here today is the problems of 1975, based on global cooling, and the problems here, based on global warming, appear to be the same problems. Wouldn't you agree that, in fact, if you have a change of 7 or 8 degrees and a change in how much water falls where, marginal areas up or down, we are going to be affected and affected fairly dramatically? Isn't that true?

Mr. FINGAR. I can't argue that it isn't true.

Mr. ISSA. Okay, then, following up, because I have very limited time and I want to get to just one single point in this, I appreciate what the Intelligence Community brings to us.

For purposes—this is a committee on global climate change mixed with a Committee on Intelligence. For purposes of intelligence, no matter what we give you in hypotheticals, a rise of 7 degrees, a fall of 7 degrees, inability to grow crops in India because they burn cow dung and the sky doesn't allow enough sun to get in, whatever the hypothetical we give you, isn't it true that you are prepared and that one thing that we can count on is that you will give us some analysis of what will happen if, but, in fact, you cannot really feed accurately within your resources of any of the intelligence agencies the input of whether the temperature is going to

go up or down, whether the temperature is going to cause or not cause a drought?

What you can do is deal with any hypothetical we give you as to global climate change and come back to us and say, yes, if you cut off the water in X country or if this country has a crop failure, we can give you an analysis of the impact to America's security and the stability of those countries. Isn't that essentially what we are—the relationship that we should have with your agency?

Mr. FINGAR. Yes, that is correct.

Mr. ISSA. Okay.

Mr. FINGAR. If the question is posed as what would be the implications of—make up the hypothetical or pick the scientific study. What would change would be sort of the confidence level, about whether it was purely hypothetical or was grounded in real-world experience and the quality, as judged by those able to do so, of the underlying science.

Mr. ISSA. Doctor, I hated to make it as painful as it was. It is very important. I appreciate the Chair's indulgence. It is very important. I appreciate that you and the agency, that all of the agencies of the Intelligence Community are very good at giving us these hypotheticals and not qualified per se to look into climate change, but, rather, given a set of scenarios that might occur, giving us a reasonable projection and, as you said, I think very importantly, Mr. Chairman, that we delve into a deeper—that the very mitigations we have to analyze whether those mitigations have side effects.

I appreciate the Chairman's indulgence and yield back the time I also don't have.

The CHAIRMAN. The gentleman's time has expired.

The Chair recognizes the gentleman from New Jersey, Mr. Holt.

Mr. HOLT. Thank you, Mr. Chair, Madam Chairman. I appreciate your putting this hearing together.

Just to follow the line of questioning from this morning for just a moment longer, let me ask, Dr. Fingar, why you chose the IPCC judgments. And I gather this was not just a randomly selected essay that somebody tossed off the top of their head and that you, as I recall from reading the assessment, you actually subjected it to some analysis about how conservative it was or how far out it was.

Mr. FINGAR. I would like Matt to answer that.

Mr. BURROWS. We selected the IPCC fourth assessment as well as other—we selected the IPCC's fourth assessment report as well as other peer-reviewed scientific material, because, first, it was—IPCC report was peer-reviewed and accepted by the U.S. government. So it was, in our minds, the consensus document by which to use as a base, then, for analyzing the security implications of climate change.

Mr. HOLT. Thank you.

The other question I would like to pursue—and I am sure there won't be time to exhaust it—but it is something that, Dr. Fingar, you and I have discussed before. It is the implications for the way we do and collect intelligence, collect and analyze intelligence in the United States.

For 50 years, partly because of the Cold War mentality, and for various other reasons, our intelligence, both the budget, the directives and the way the analysts think, has been oriented toward politico/military issues. It has all been, you know, in shorthand. We might say we have been practicing criminology, trying to get inside the political dynamics in the world.

You said you had to use a different methodology in putting this together. I wonder if we shouldn't be using that different methodology more often in more other areas. Because by focusing on the politico/military dynamics, we can sometimes miss things that are perhaps of even greater import.

Mr. FINGAR. I absolutely agree with you on two dimensions, maybe more than two, specifically. One is thinking about our national interest or national security in ways that are broader than they were in the past. And certainly the range of questions that are posed to the Intelligence Community now come from a much wider spectrum of U.S. government agencies, and the old way of doing things is inadequate to new problems.

The other is the reaching out for information that is not inherently sensitive or classified because we stole it, because we used very sophisticated methods to achieve it. Engaging with experts inside and outside of the United States government, inside and outside of the United States has become—is increasingly important and now soon to be mandated by DNI McConnell as a part of what is expected of all analysts in the community.

Mr. HOLT. So I gather part of this different methodology that you recommend means a better use, more integrated use of open-source information.

Mr. FINGAR. Absolutely, absolutely.

Mr. HOLT. You are alluding to the fact that in the Intelligence Community there is this belief—a fallacious belief, I might say—that hard-won information, in other words, information gained surreptitiously or through expensive national technical means, is somehow better information than you might get. It is certainly harder, one, but it is not necessarily better than what you can get from open sources.

Our time is expiring. I thank you for your observation.

The CHAIRMAN. Did you want to add something, Dr. Fingar?

Mr. FINGAR. No, but if I may beg the Chair's indulgence, I am watching the clock because I have an airplane to catch. So if it becomes necessary for me to turn it over to my colleagues, please indulge me. I thought we were going to end at 11:00. I had scheduled around that.

The CHAIRMAN. Let me now turn and recognize the gentleman from Oregon, Mr. Walden.

Mr. WALDEN. Thank you very much, Mr. Chairman.

Dr. Fingar, what level of confidence do you have in your assessment? What level of confidence do you apply to this assessment?

Mr. FINGAR. The confidence level we have applied is of low to moderate, the reason being the cascade of uncertainties. There was uncertainty about the climate change projections that we took as the base lines. There was uncertainty about the impact on the individual countries. There were uncertainties about the judgments of the experts we consulted about the ability of different countries

and regions to cope with them. So that that cascade of uncertainties gives us a bottom line of low to moderate.

Mr. WALDEN. Of low to moderate on your assessment. So as we read this, the public version of this document, we should assume that your confidence level behind it is low to moderate?

Mr. FINGAR. Correct.

Mr. WALDEN. Why publish something at that level?

I understand the answer. I was hoping to get it from him.

Dr. Fingar, why publish at that level? Will you stand behind this report?

Mr. FINGAR. We will stand behind it. We will stand behind the methodology we used, and one of the reasons I used as much of the time for my presentation to lay out that methodology so people would understand what we did to reach the conclusions.

Again, just to close the loop, if you meant publish in the sense of public, we were asked to present an unclassified statement for the record. The National Intelligence Assessment is classified.

Mr. WALDEN. All right, let me switch gears. Because when I think of national security and global climate change and all of these issues, I also see the issue of food security and energy security, being able to grow crops. I represent a very arid part of Oregon, 70,000 square miles where, you know, the line, whiskey is for drinking and water is for fighting. It has gone on for 100 years.

I sense in global climate change as part of what is in the public report is you are going to have different moisture regimes which will affect crops, which will affect food stocks, correct?

What you have done is take the published data, scientific data, analyzed that and tried to apply it on a country-by-country basis to determine what we could anticipate happening in those countries with the known science of global climate change. And to all of that you apply the low-to-moderate confidence level in your findings; correct?

Mr. FINGAR. To the assessment we make of the national security implications for the United States is the bottom of that cascade.

Mr. WALDEN. Okay. So then when we are talking about the national security interests of the United States, as I watch the food price crisis around the world, as I watch the energy crisis here in this country and around the world, as I talk to my constituents, the farmers and ranchers, who provide a lot of the food that is, frankly, exported in terms of wheat and other grains around the world, it seems to me that our energy lack of independence in the United States, the price of oil, fertilizer and other inputs, is having a very significant impact on stability around the world.

Then you look at the money we are sending to, oh, Hugo Chavez at $130 million a day for oil out of Venezuela, the money going into China and Russia, is that also not a security issue that may be even larger than what we are facing with global climate change?

It seems to me that the Chinese and the Russians are becoming more financially independent at our price because we are sending the money for oil and all to them. Aren't they building up their militaries? Doesn't that provide a bigger issue we should be focused on?

Mr. FINGAR. It is a different issue——

Mr. WALDEN. I know that.

Mr. FINGAR [continuing]. That I am unable to size in a comparative way.

Mr. WALDEN. So you think global climate change issues are equal then, is that what you are saying, to what we are seeing unfold today on the energy picture?

Mr. FINGAR. I will invite——

Mr. WALDEN. Yes, maybe somebody else.

Mr. MOWATT-LARSSEN. Well, I would agree with your principal contention that it is very useful to look at the climate issue in the context of energy, obviously. In fact, I go so far to say they are more or less a single equation of state. As you change energy policy, you will have positive or negative environmental consequences, including on global warming. In fact, I would use a quote that maybe captures one element of that from the World Economic Forum, Global Futures Report from this year.

They stated, "The failure to develop a holistic policy approach to management of both energy security and reducing carbon emissions may end up threatening both objectives."

I think, of course, that will also affect, as we look into the future on this issue, the kinds of confidence we have in our analysis will depend largely on the variability of the studies.

The CHAIRMAN. I hate to interrupt, only because Mr. Fingar has to leave, and I would like some of the other members—the gentleman's time has expired. I apologize to you.

The Chair recognizes the gentleman from California, Mr. Thompson.

Mr. THOMPSON. Thank you, Mr. Chairman. Thank you for holding this hearing.

I thank you for being here to provide testimony, and I just want to add my thanks to all the people behind putting together this work. The estimates are a fabulous help to us, and now I appreciate all the work that goes into it.

I just want to point out that all of your estimates are based, more often than not, on judgments. Your judgments are based on uncertainties, and that is kind of the nature of the business that you are in.

Also, I think it needs to be pointed out that when you label something a certain confidence level, that is an accumulation of everything, that there is parts of your work that have higher confidence ratings than others, as I understand it, from my position on the Intelligence Committee. So I think that needs to be pointed out in the beginning.

But I, too, had concerns about the IPCC's findings and wanted to know whether or not these are things that we could take to the proverbial bank.

I met with a group of scientists from one of the universities in my district, the University of California at Davis, an agricultural institution, and all the scientists I met with, they just kind of shrugged. They said, well, of course this is good stuff. You just have to remember, it is a consensus report. So this is kind of like the lowest common denominator. They were already at the point where this was accepted.

I also want to point out that the private sector is certainly, in my district, is interested in this type of work. I represent an area,

the main crop—agricultural district—the main crop is a wine grape, fruit for wine productions; and every vineyard in my district on their own is out trying to figure out how to reduce their carbon footprint.

They know it is good for business. They know it is good for their survival. And they look at things like the increase in temperature; and, already, the warming in California, the increased temperatures in California are already responsible for the introduction, they claim, of two new pests per month.

This has an impact on the business, and the private sector is going out there. They are installing solar panels. They are burning different types of fuel, different types of farming practice. They are investing a lot of money out of pocket because they know that this is important.

A lot of it is based on data that has been made available; and it seems to me that we should be looking at how to make all of the data available so everybody, governments—not only local governments and State governments here but governments around the world—we can work in conjunction with them to deal with what would be devastating geopolitical problems if this comes about.

I guess I would like to hear from you, Dr. Fingar, regarding the making public, declassifying this information, so we can have the benefit of working across agencies, working across governments, working globally to deal with this.

Mr. FINGAR. Let me respond to three points that you made.

One is the Intelligence Community is used to working with uncertainty, working with partial information. That is what we do all the time. That is why we exist. If we have all of the information, you wouldn't need to hire us. So we are used to trying to piece together a 1,000-piece puzzle when you have 15 pieces and somebody lost the box cover.

Dealing with the uncertainties around the IPCC report, okay, that is what we know, in quotes, and as a starting point, so we will take that and work with it. So in that respect what we did here is what we normally do on a different kind of subject and difficulty to go back at the sources of information.

The peer review character is important to this. It is a peer—the IPCC report is peer reviewed. It is biopharmaceuticals, farmers apply fertilizer on the basis of sort of peer-reviewed papers of one kind or another. It is not just another hypothesis.

But the classification of the NIA is one that there is several reasons here. It was not a NIC decision. The decision to have it classified was the National Intelligence Board, the heads of the 16 agencies meeting together chaired by the Director of National Intelligence.

Part of it is we are reluctant to have our input to decisionmaking become a part of the debate. We believe decisionmakers need the chance to work it.

The issues, the problems that are identified in our assessment here are such that, if they are going to be tackled, there is going to be extensive engagement by the United States, many components of the United States, with other governments, with international agencies.

Our experience and our judgment is that we would complicate and make that much more difficult if we were to sort of identify who are the winners, who stand to benefit if nothing happens, which governments we consider to be to incompetent to manage the problem. Do we direct money to the most competent or the most incompetent? Where there are the most people affected or likely to have the shortest——

There are many, many policy decisions that seem to me could be informed by this report and that stigmatizing in some way the potential partners by the judgments that we make about them strikes us as the wrong way to go about it.

The CHAIRMAN. The gentleman's time has expired.

The Chair recognizes the ranking member of the Intelligence Committee, the gentleman from Michigan, Mr. Hoekstra.

Mr. HOEKSTRA. Thank you. Just a couple of questions or comments.

Low to moderate means you don't know. I mean, we have read National Intelligence Estimates where there are high confidence in those types of things, and they have proven to be wrong. And even in their high confidence it says, you know, we could still be wrong. Low to moderate means—I believe that is accurate, correct? You really don't know?

Mr. FINGAR. Yes.

Mr. HOEKSTRA. It is a pretty low standard.

Mr. FINGAR. Yes, but this is not a fact.

Mr. HOEKSTRA. But it is a very low standard in terms of the rankings as to what we see in national intelligence assessments?

Mr. FINGAR. Right, but this is one of the things that you will appreciate, being on the Intelligence Committee, where the estimates, where the confidence levels are based on the quantity and quality of the information we have available.

Mr. HOEKSTRA. Right.

Mr. FINGAR. Those kinds of criteria, trying to take it out to different kinds of information, we have got a lot of information of which we are incapable ourselves of assessing the quality.

Mr. HOEKSTRA. The second, what value, exactly, did the Intel Community add to this process in terms of HUMINT collection, SIGINT collection, you know, clandestine collection? Where was the value that the Intel Community added in this?

Mr. FINGAR. There is—correct me if I am wrong in that, but there is no clandestine collection involved in this. It is just working with open-source information. And the value was the experienced analysts who know how to look at national security implications of various situations—country specialists, region specialists, economic specialists, military specialists, who were able to look at the data that came out of stage three.

Mr. HOEKSTRA. We don't have that at State?

Mr. FINGAR. You have some, of course——

Mr. HOEKSTRA. I mean in terms of taking a look at global trends and these types of things, the Intelligence Community is in a better position to do that kind of analysis on global trends than what we have in the State Department?

Mr. FINGAR. I don't know if the Congress asked the State Department for this. They asked us to do it. You asked us to do it.

Mr. HOEKSTRA. Why can this report not be declassified?

Mr. FINGAR. I don't have anything to add to the answer I just gave your colleague from California.

Mr. HOEKSTRA. I mean, I support the chairman of this Select Committee in terms of asking for the report to be declassified, because I see—I don't see anything that the Intel Community has added to this study. I don't see any disclosure of clandestine, covert information, as far as I can tell.

I would welcome this report to be studied or to be released to see how little value I think was received as an output of, perhaps, good work by the Intel Community but tasking the wrong people to do the work. I am all for releasing this.

Ms. ESHOO. There is a bipartisan sensibility on this.

Mr. HOEKSTRA. Yes. I see no intel value that came out of this report that says, wow, we really need to protect these sources, methods or process.

Mr. SENSENBRENNER. Will the gentleman yield?

Mr. HOEKSTRA. Yes.

Mr. SENSENBRENNER. I agree that this should be declassified, as well, based on Dr. Fingar's testimony that there wasn't any clandestine information that added value to the report.

Mr. HOEKSTRA. I said this from the beginning. We are asking the wrong agency to do the wrong work. There are other more pressing intelligence needs that are out there right now.

I would apologize for Congress asking you to do this work in the first place. This could have been—as you have said, most of this is open-source information. You have gone through it. You have reviewed it. You said, hey, if there is climate change—and, as my colleague pointed out, if temperatures go up we have got a problem; if temperatures go down, we have got a problem, you know; and we can say that with low-to-moderate confidence.

There are a lot more pressing issues out there for the Intelligence Community to be focused on right now that would help keep America safe and that would actually enable the Intelligence Community to do what I think we are spending $40 billion a year on, and it is not speculating on open-source information. It was a waste of time, a waste of resources for the Intelligence Community to be focused on this issue versus other folks in the government that could have done this job and have a responsibility for doing it.

I am assuming we didn't go—did we task anybody to go into these countries and to ask whether countries were developing strategies potentially to deal with global warming in these areas?

Mr. FINGAR. We did not.

Mr. HOEKSTRA. I am sorry?

Mr. FINGAR. We did not.

Mr. HOEKSTRA. I mean, I would think that is what we want to know. Does Russia, do countries in Africa, are they thinking about global warming? Are they tasking and developing plans to deal with global warming, instability? If they are, what those are?

That is what I think would be of interest from the Intelligence Community saying, you know, get into these governments and see how they are planning on dealing with it. Because that would be the insight that the Intel Community could give us that we can't

get from open sourcing. But it appears that that didn't even happen.

With that, I yield back my time.

The CHAIRMAN. The gentleman's time has expired.

The gentleman from California.

Mr. ISSA. Mr. Chairman, at this juncture I would ask as a unanimous consent that the Chairs and the ranking members prepare, at the end, the conclusion, a request for a declassification; and in lieu of declassification, if that is turned down, that we have a redacted version so that all of us on the committee can see what, if anything, is being held as closed. Because, clearly, the vast majority of this document, if not the entire document, should be declassified.

The CHAIRMAN. I thank the gentleman for that suggestion. I would propose that we do work together jointly as committees; and the majority and the minority can go on to accomplish that goal, I think. I thank the gentleman for that proposal.

Mr. FINGAR. Mr. Chairman, if I may beg your permission to catch my airplane, my colleagues would—but we would certainly receive the committees'—the joint two committees——

The CHAIRMAN. Could I ask you, Dr. Fingar, if you could just answer questions from one more member before you leave? Is that possible? I mean, is it a classified time that your flight is leaving?

Mr. FINGAR. No, it is a 12:30 flight.

The CHAIRMAN. Oh, 12:30 flight. I think, out of courtesy to the gentleman—I apologize to the members.

We thank you.

Mr. FINGAR. But my colleagues are very well-equipped.

The CHAIRMAN. All right. Before you do leave, sir, do you stand by the conclusions in the National Intelligence Assessment?

Mr. FINGAR. Yes, I do. Yes, I do. And I would pick up on my exchange with Congressman Holt that the fact that the material we used in this was not classified, it does not lessen the significance of having the Intelligence Community analytic capabilities arrayed against it. Information is information. Knowledge is knowledge. How we get it and so forth is less important than does it inform our judgments. And I absolutely stand behind this, both the statement and the assessment.

The CHAIRMAN. Thank you, Doctor, very much and thank you for your contributions to the security of our country.

The Chair recognizes the gentleman from Missouri, Mr. Cleaver.

Mr. CLEAVER. Thank you, Mr. Chairman.

Thank you, Dr. Fingar, for being with us today. We appreciate it.

Because of the international nature of intelligence, how would you gauge the sharing of information between the U.S. and allied nations, particularly as it relates to this issue, climate change and security? The point I am making is we obviously have to depend on other nations as we secure intelligence. Is that a free-flowing or is that a difficult proposition?

Mr. BURROWS. In terms of this study, we did share the analysis with our commonwealth partners and also solicit their comments and reactions to it at several different stages. We also have had,

also, interaction with other services in other countries on this issue, so I can——

Mr. CLEAVER. Are we perceived, as best you can determine, as 21st-century thinkers with regard to climate change? Are we perceived around the world, with our allies, as 21st-century thinkers?

Mr. BURROWS. You are talking about the Intelligence Community?

Mr. CLEAVER. Yes, yes.

Mr. BURROWS. Certainly on this issue, I mean, they were very interested in our analysis and, for the most part, shared and agreed with the conclusions of it.

Mr. CLEAVER. What—either, any one of you, what is it, do you believe, to be the greatest threat to national security caused by the effects of climate change?

Mr. BURROWS. Well, I think as we, as Dr. Fingar indicated in his remarks, and we put in the statement for the record, it is the fact that it has this cascading effect on other problems. So it is really the confluence of climate change and the impacts on various parts of the world with what are already existing problems. And there is a long list of these that he mentioned in his statement, you know, poverty, a marginal agricultural production to begin with, migration issues and so on. So it is, actually, the inner section of climate change with these others that is the most troublesome.

Mr. CLEAVER. I read an article recently where the writer was talking about the problem—the problems we are going to have with water. They talked about the fact that Lake Meade in California would probably be bone dry in 12 years, and they said there would probably be wars fought over water, or conflicts fought over water, the Nile, the Jordan. Is that an exaggeration?

Mr. BURROWS. It is an exaggeration in the sense that it is not inevitable. In fact, on, you know, on water, these disputes have existed in some ways for some time. I mean, we detail action in reports, some—there are some existing water problems.

The key is if you have an institutional mechanism in place for sorting out water disputes, I mean, that then decreases the risk of a conflict happening. So it is correct to say that these could be water—who siphons off water, how much water, scarcity, there is all these factors, increase the risk of tensions and conflicts. But it is not, I don't think, fair to say that that conflict is inevitable just because you have these facts.

Mr. CLEAVER. Thank you.

I yield back 28 seconds, Mr. Chairman.

The CHAIRMAN. I thank the gentleman very much.

The Chair recognizes the gentleman from Pennsylvania, Mr. Murphy.

Mr. MURPHY. Thank you, Mr. Chairman. I appreciate it and appreciate the time; and, to the panel, thank you very much for your service and the report.

I would like to focus—I am a member of both the Intelligence Committee and the Armed Services Committee. I would like to focus my first question on the declassification decision and go down a little bit there. Mr. Mowatt-Larssen, I appreciate your service to our Army, to the CIA, now the Department of Energy. I had the great honor of teaching at your alma mater, West Point.

I know Dr. Fingar said it. I wrote it down here. He said it wasn't a NIC decision. You were privy to this. Whose decision was it not to declassify this report?

Mr. MOWATT-LARSSEN. Well, we, as one of the 16 agencies in the Intelligence Community, of course, we participated in the discussion about both on the content and then in the consensus on how to handle it. I would just have to echo Dr. Fingar's comments that we, of course, supported that decision.

I think the——

Mr. MURPHY. Can I ask you to slow down a little bit? Of the 16 entities, though, was it someone from those 16 agencies that said we should not declassify this or is it someone above those agencies?

Mr. MOWATT-LARSSEN. I am not privy to specific details other than the fact that we all participated in the process of both drafting the document—particularly the Department of Energy, with our national laboratories in particular. Our primary contributions to the NIA were scientific expertise, as you imagine, on some levels and computer modeling and then, of course, also as an intelligence entity within the Department of Energy.

So I would defer to my colleague, Matt, on any further drilling down on that process of classifying.

Mr. MURPHY. I am sure you understand we are a little bit perplexed why you did not declassify this document. Why it was classified to begin with?

Mr. BURROWS. Well, again, as has been alluded to at the National Intelligence Board meeting, all the 16—which is chaired by the Director of National Intelligence, all the 16 agencies sit around the table and one of the questions deals with the classification and the release, so on, to allies. In that session, there was a unanimous agreement by all the agencies to not declassify this report.

Mr. MURPHY. It was a unanimous decision to classify it?

Mr. BURROWS. To keep it classified.

Mr. MURPHY. Okay, I just wanted to be sure.

I am going to change over to the armed services side here.

If you could elaborate on as far as what you think the most significant impact on U.S. homeland security, specifically as relates to when you look at global warming, the rising of the water—a lot of our military bases are on the coastline. When you look at San Diego shipbuilding, when you look at Connecticut and Groton, shipbuilding there as well, but also the other military bases, the Marine Corps and the Army. Could you elaborate on that effect on Homeland Security and the implications there?

Mr. BURROWS. Okay, we actually identified three areas—broad areas where the impact would be greatest on U.S. homeland, and that was dealing with the drought in the Southwest. Then, secondly, the infrastructure along the east coast, and this would be affected by storm surge.

Mr. MURPHY. And third?

Mr. BURROWS. And third was dealt with these installations as well as nuclear power plants. Most of them are located—I mean, the military installations that we looked at are located along the coast, so it is linked with the second.

Mr. MURPHY. What recommendations does the panel have that this Congress should be aware of that we should move forward on when you look at those three areas that you targeted?

Mr. BURROWS. Well, as members of the Intelligence Committee, we don't make policy recommendations. I mean, we tell you what we think based upon the climate science and also, you know, what the data tells us about possible threats. We don't actually recommend particular steps to be taken.

Mr. MURPHY. So, in your professional judgment, you can't give us any idea what we could do to mitigate potential damages of global warming?

Mr. BURROWS. No. In the first place, that is not our job. But, also, in the second place, as we have talked about here, we didn't actually look at mitigating strategies in any depth.

Mr. MURPHY. I see the balance of my time has expired. I thank the gentleman.

The CHAIRMAN. I thank the gentleman.

The Chair recognizes the gentlelady from California.

Ms. ESHOO. Thank you, Mr. Chairman.

I just want to get something down for the record that I think really is very important, especially around this whole area of confidence levels in NIEs and, in this case, the NIA, and that is on Iraq having chemical and biological weapons and was close to making a nuclear weapon.

Of course, this was all put out in the run-up in the rationale to invade Iraq. That was high confidence. So I think that we need to understand the context of these things and maybe even remember the old Boy Scout motto, "Be prepared."

I think if this discussion is about anything, it is about using the science, not political science, but using the science and the best minds of our Intelligence Community to be prepared and to map out a plan not only for our own country but to work with nations around the world. Because it threatens the entire global community.

Thank you, Mr. Chairman.

The CHAIRMAN. I thank the gentlelady.

The Chair recognizes the gentleman from California, Mr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman.

Nuclear winter, or the lack of it, has been brought up twice by members on the other side of the aisle as a relevant example of alarmist predictions that never took place.

Well, I am delighted that nuclear winter never took place, but the very fact that nuclear winter was brought up in this context shows a complete lack of understanding of what nuclear winter pertains to, namely, that it is a consequence of nuclear war, which helps explain some of the gross misunderstandings we are seeing with regard to the national security and economic implications of global warming.

Now, much better analogies are CFC emissions impacting outer atmosphere ozone and acid rain. In both of these cases, national action and global cooperation mitigated the threat without destroying the U.S. economy, contrary to the dire predictions of the same crit-

ics who believe that mitigating climate change will have dire consequences to our economy.

Now, Dr. Burrows, you wrote in the testimony, I assume, that you are at least participating in that, that as scientific modeling improves intelligence agencies will see more valuable studies and more valuable data. Are there any scientific capabilities needed that don't exist and for which none is being developed?

Mr. BURROWS. Well, on the—as far as scientific capabilities in the Intelligence Community, I think Dr. Fingar explained—I mean, what we are looking at is using the capabilities outside the Intelligence Community on this issue of climate change. We are not looking to develop within the Intelligence Community, particularly, scientific capabilities, because we see that as a duplication and probably not a very good use.

Mr. MCNERNEY. Well, are there capabilities that need to be developed that aren't being developed that you could identify?

Mr. BURROWS. I am not qualified on a scientific side to say what scientific capabilities need to be developed.

I can tell you, as we have put out in the testimony, areas where we would like to put more of our effort in looking at the security implications, but I can't tell the scientific community outside what they should be doing.

Mr. MOWATT-LARSSEN. Sir, if I may add to that.

Mr. MCNERNEY. Sure.

Mr. MOWATT-LARSSEN. I think your question really touches on a very important philosophical point. The ownership of this problem, in particular, touches on all communities. The Intelligence Community undoubtedly has a role to follow the NIA, but so do, for example, the Department of Energy and national laboratories.

We have extensive capabilities. I can't speak to all of them, with things like computer modeling, renewable and energy-efficiency technologies, mitigating greenhouse gas emissions, systems dynamics analysis, rural data center atmospheric trace—just a sampling of capabilities in our own national laboratories. There the culture is this great transparency of collaboration internationally with foreign partners, foreign countries, foreign scientists. I think one thing the Intelligence Community can do to build on some of the discussion up to this point is exploit our open source, open innovation capabilities, to bring all that in as best possible to improve, to improve our baseline.

The NIA is a baseline. It is not the end product of where we are going to end up on this; and the key is this international collaboration, private/public sector partnership.

Mr. MCNERNEY. Well, it was recommended that the Intelligence Community should conduct a scenario exercise. Aren't these scenario exercises already being conducted?

Mr. BURROWS. Yes. I mean, we routinely conduct scenario exercises. This pertains to a scenario that are not scientific scenarios but ones dealing with implications of security, political and economic and so on. We do that. As the testimony indicated, we would like to do more of this, particularly when it pertains to this issue of climate change.

Mr. MCNERNEY. Well, much of the oral testimony that Dr. Fingar gave had to do with a methodology. How confident are you—and

this is a question that has been circulating this morning—how confident are you of the methodology that was used?

Mr. BURROWS. I think we are highly confident of the methodology that was used just for the purposes, I think, that all of us related, that we went out and sought out, as best we could, the expertise on the outside, both in terms of the science and, secondly, also using outside experts along with IC experts to determine the implications. But this is done—as we put in the report, this is an imprecise science. I mean, you are dealing with a 20-year projection. There are a lot of factors. You cannot be totally certain of how these things will work out.

Mr. MCNERNEY. Thank you, Mr. Chairman.

The CHAIRMAN. The gentleman's time has expired.

The Chair recognizes the gentleman from New York, Mr. Hall.

Mr. HALL. I thank you, Mr. Chairman.

Mr. Burrows, you just said you had a high confidence in your methodology. Dr. Fingar said that he was working from the mid-level assessment of the IPCC, which is a document that has been accepted by our government and is a consensus of scientists from countries around the world. That was corroborated by peer review by the Climate Change Science Program, Department of Energy National Laboratories and the National Oceanic and Atmospheric Agency, or NOAA—none of which are tree-hugging environmental groups, by the way, to my knowledge—also, the University of Maryland, the Pacific Northwest National Laboratory, the Naval Postgraduate School, et cetera, et cetera. At what point and by whom was this rating of low-to-moderate confidence given to the report?

Mr. BURROWS. Well, this happens in the cases of all National Intelligence Assessments and Estimates.

Mr. HALL. I just want a simple answer, because I only have 4-minutes.

Mr. BURROWS. Okay, it is done at final stage of the coordination process. This is a working-level coordination.

Mr. HALL. By whom, please?

Mr. BURROWS. All the agency reps at the coordination session.

Mr. HALL. I would love to know the names of those people.

In terms of low confidence or moderate confidence, how confident are you right now that the Mississippi River is flooding and 300-plus miles of shipping are closed due to high-water levels?

Mr. BURROWS. High, confident.

Mr. HALL. How confident are you that five Boy Scouts were sucked up in a tornado and killed in the last few weeks?

Rhetorical questions, okay.

How confident are you that there is an early fire season starting and raging in the Rockies and California mountains?

How confident are we that a typhoon just killed 800 people on a cruise ship or a ferry in the Philippines and shortly before that a cyclone killed many people in Myanmar?

How confident are we that there is a drought in Georgia and north Florida that was so severe that last year they had to close nuclear power plants because there wasn't enough water for the cooling system? Do you remember that?

Mr. BURROWS. Yes, these are all facts.

Mr. HALL. Your report says "increased intensity and frequency of severe weather events" are likely. How confident are you that these phenomena we are witnessing in seemingly more and more frequent sequence could fit the model that your report describes of increased intensity and frequency of storms?

Mr. BURROWS. I am not, on that level, confident.

Mr. MOWATT-LARSSEN. Sir, to the point on the low-to-moderate confidence, I think it is very important to note that that assessment is based on the variability of the science listed. It is not to suggest that it is conservative or pessimistic but that, in fact, as we know more about the science, as the science is a greater consensus across the board, we may, in fact, determine that we have underestimated the threat as much as we may have overestimated it. There is no suggestion in low to moderate that the problem is not real.

Mr. HALL. Oh, thank you for saying that you may have underestimated. I am glad to have that on the record.

The one thing I agree with my minority colleagues about is that this report should be declassified in its entirety with no redacting. I didn't see anything that I thought needed to be redacted.

Mr. MOWATT-LARSSEN. Sir, there is one thing in the report, if I might add to your point, that would talk about factors that may dramatically change our assessment. Tipping points, those are included in the reports as illustration of some of the viewpoints that still may ultimately greatly affect the outcome of our assessment.

Mr. HALL. Right, and the more information that is withheld from the public, the harder it will be to convince people that climate change is happening and that we need to make the right decisions, not only for our national security but for our economic security.

We could have invented Prius here, but decisions made by our government and our industries allowed somebody else to get to that hybrid technology first, and we are suffering from it. Our national security is suffering through the increased use of foreign oil and the flow of dollars overseas.

I want to ask one last question, because I know I am going to run out of time on the answer.

The scenarios described today by you would potentially—with the U.S. potentially being drawn into humanitarian interventions because of refugees of climate change crossing boundaries in our hemisphere, among others, the necessity of the United States to referee fights over water throughout the globe are truly daunting.

As we have seen in Iraq, a large sustained military effort has had a draining effect upon our military and National Guard. I am curious what your thoughts are. Under the scenarios laid out in the report, what would our military end strength need to be to address these new challenges while still meeting traditional national security demands? How much additional spending would that require?

Mr. BURROWS. Well, again, we can't make any recommendations on specific spending requirements. What we indicated there was that, in view of the conclusions that we drew that humanitarian situations were more likely to occur in the future and the U.S. would be probably, as you say, drawn into it, and that is the extent of the analysis and judgment.

Mr. MOWATT-LARSSEN. I might add to that as well. I think that question specifically raises the broader question of what will policymakers need in the future to answer questions like that and what will they need from us. I think the very simple response to that is adequate forecast, foresight and warning. In a classic intelligence context, how long ahead of problems will they need that foresight and warning and what will it consist of?

Mr. HALL. Mr. Chairman, thank you.

I just want to close by saying that I hope that the modest economic benefits that you show the United States gaining from global warming do not include the flooding of Cedar Rapids or the three 50-year floods in the last 5 years in my district in New York.

I yield back.

The CHAIRMAN. The time of the gentleman has expired.

The Chair recognizes the gentleman from Washington State, Mr. Inslee.

Mr. INSLEE. Thank you.

Just reading the Doctor's report, it says, "We judge global climate change will have wide-ranging implications for U.S. national security interests over the next 20 years. Climate change could threaten domestic stability in some States, potentially contributing to intra- or, less likely, interstate conflict, particularly over access to increasingly scarce water resources. We judge that economic migrants will perceive additional reasons to migrate because of harsh climates, both within nations and from disadvantaged to richer countries."

Now, I don't think you have to be an intelligence or secret agent with classified experience to recognize this is a security concern of the United States. I want to ask you about what we are doing about that.

Many of us believe we should stop global warming so we can eliminate or reduce these security threats of the United States. I want to ask how we go about that.

I want to refer to a chart. This is a chart showing our research budgets for a variety of national enterprises.

On the left is the chart for the research budget. This is the research budget for the United States for our entire energy R&D research budget. You see it peaked in 1980. It has gone down since. It is about $3 billion per year. This is the research budget for our health expenditures in the United States. It is up to about $34 billion a year.

On the right is our traditional DOD research and development budget. We see it has gone up precipitously, is now in excess of about $82 billion.

We are spending about $82 billion a year on R&D on weapons systems, but we are spending $3 billion a year trying to prevent the most massive weaponized system against the very climate system upon which life depends on the planet Earth. To me, there is a serious question whether or not we are doing adequate research and development to prevent this security threat to the United States.

If you think these, with all their terror, are in Afghanistan and Iraq, this weapons system that we are unleashing on the world is going to have national security implications well beyond any local-

ized conflict. I think your report makes that clear. Yet we are spending peanuts, crumbs or less. We are spending 55 times more money fighting war in Iraq in this oil-rich region than we are trying to figure out a way to stop climate change and developing clean energy for the future of the country.

So it is a bit rhetorical, but I will ask the gentleman or gentlelady to comment about whether or not having an adequate research and development budget to build clean energy technology for the United States, to prevent global warming, to prevent the internecine conflicts in the Sudan—they are raging today over water, not 20 years from now. They are fighting over grass and water in the Sudan and Darfur today. We are experiencing forest fires in Alaska, in Georgia, and floods. We are experiencing rainfall that closed a national park for the first time in 140 years, today, not 2030.

So I would just ask you, do you think it makes sense, given the security implications of global warming, that we do a little better job on our research and development budget to make it consistent with the nature of this threat?

Ms. MONAGHAN. I think, as Dr. Burrows indicated, we in the Intelligence Community don't make proposals about what policymakers should decide. But I think, after doing this report, the one thing that became very clear is a lot of this is about trade-offs. One of the reasons we did such a—more than a 20-year projection is because some of the decisions that will be made will need a long time horizon in order to get an impact. When you are talking about the food and fuel crisis today, any solutions to that crisis, if implemented today, would take 10, 15 years to pan out.

So, it is all about trade-offs, and it is all about thinking about, you know, if you make one decision on mitigation or adaptation, what are the implications of that? I think that is what we were beginning to unpack in this assessment.

Mr. INSLEE. Well, let me just ask you for your thoughts. I understand your limitations, but, you know, doesn't it seem to you that if we can prevent a very significant increase in world-wide tensions—and I think it is very clear that this is going to cause a very significant increase in worldwide tensions, which has the possibility to result in conflicts that one way or another we get dragged into. We have got troops all over the globe because of local tensions that have boiled over or may boil over. Doesn't it make sense to try to prevent those tensions from developing, to try to reduce national security concerns of the United States, and is an R&D budget critical to that?

Mr. MOWATT-LARSSEN. I would add taking that to a broader level of providing the kind of information to policymakers, to informed decisions, whether that is over R&D budgets or over decisions of where to put our priorities. And I agree with my colleague. We have to think of those things in a much broader sense.

One of the things that hasn't come up today is that this effort, if we are going to understand global warming in the proper context, beyond the science, it is going to involve—has to involve a multidisciplinary, global, international-type approach, bringing best knowledge everywhere, to put that into information that we get

better at providing over time to our policymakers so they can make informed decisions.

Mr. INSLEE. We have got a lot of knowledge. We just don't have any action after 8 years, this administration. We are going to start that in the next one.

Thank you.

The CHAIRMAN. The gentleman's time has expired.

All time for questions of this excellent first panel has expired. We thank you so much for the work that you have done in presenting this information to us.

Again, on a bipartisan basis, we are going to be making a request to you to declassify this document—not to you specifically but to the administration—so that we can have a fuller discussion of the basis upon which this analysis has been made.

With the thanks of both committees, we will now move on to the second panel. Thank you so much.

The second panel consists of four or five very distinguished citizens of the world. But because of our time constraints and her inability to stay with us for a longer period of time, I would like to ask that we allow our first witness to give her testimony. She is the Right Honorable Margaret Beckett.

Mrs. Beckett is joining us today in her personal capacity as the former Foreign Secretary of the United Kingdom. We understand that you will have to leave after providing your testimony.

Mrs. Beckett, we welcome you. We thank you for joining us today, and we thank you for your service to our planet and your time in public office. Whenever you are comfortable, please begin your testimony.

STATEMENT OF RT. HON. MARGARET BECKETT MP, FORMER FOREIGN SECRETARY, UNITED KINGDOM, C/O HOUSE OF COMMONS, 1 PARLIAMENT STREET, LONDON SW1A 2NE

Mrs. BECKETT. Thank you, sir. I have been listening with great interest to the latter part of your first panel, and I will be as brief as I can because of the pressures on your time and mine.

I think at present we are getting a sharp reminder of the impact of insecurity, whether it is energy insecurity, food insecurity, water insecurity, and the impact that can have across the world and how its fostering instability. For example, we have seen food riots in many countries across the world.

About a year ago, as Foreign Secretary, I chaired the first U.N. Security Council debate on the relationship between climate change and peace and security. Some 55 countries took part, an unprecedentedly large number for such a Security Council debate, with the Secretary General and all his senior staff—and it was the representative from the Congo who said, during that debate, this won't be the first time people have fought over land, water and resources, but this time it will be on a scale that dwarfs the conflicts of the past.

Certainly we take the view that the impact on the global economy, which I have just heard your colleagues refer, on conflict, on the risks of conflict on climate change are all linked together. We are seeing a resource crunch across the world at the moment. We are seeing, perhaps, structural shifts in the global economy which

may require a structural shift in response, and we feel that all of these things reinforce the need to address climate change.

I heard one of your witnesses, I think, indicate that energy security and climate security go hand in hand. Tackle one, and you are tackling the other.

As we look across the world in the UK, it is clear that there are countries that have greater or lesser abilities to tackle some of the impacts that we believe we will fight. But it is also clear the Stern approach that the British public published—commissioned a year ago indicates that it will not cost the Earth to change our economies in a direction which can help us tackle the impact of climate change, but it could if we don't. He insists then the minimum cost is about 5 percent of global GDP of inaction of climate change. He now says he thinks he was too optimistic.

My final point is that climate change—certainly I see, and the British government has seen—is a threat multiplier. It interacts with other problems that exist, interacts to make them worse, pressures on migration, as again has been mentioned already in your committee.

Less than a week ago, the second-most-senior official in our Ministry of Defense made the point at a meeting in London that our defense ministry sees these issues as a real threat to our national security, and we see that as being the case across the world.

Thank you.

The CHAIRMAN. We thank you very much.

[The statement of Mrs. Beckett follows:]

Testimony of

Rt. Hon. Margaret Beckett (Former Secretary of State for Foreign and Commonwealth Affairs of the United Kingdom)

Before a Joint Hearing of the

House Permanent Select Committee on Intelligence

Subcommittee on Intelligence Community Management

and

House Select Committee on Energy Independence and Global Warming

U.S. House of Representatives

Washington, DC

June 24, 2008

Dear Chairwoman Eshoo, Chairman Markey, and Members of the Committees:

Thank you for the opportunity to appear before this joint hearing of your Committees. I would like to submit my statement made at UN Security Council on 17 April 2007 for the record.

Observations made at the UN Security Council 17 April 2007

The Text of the contribution of the then UK Foreign Secretary

I will now make a statement in my capacity as the Secretary of State for Foreign and Commonwealth Affairs of the United Kingdom.

For the United Kingdom, as for my Belgian colleague and many others who have spoken today, climate change is transforming the way we think about security.

Over the past couple of years, the threat we face has grown larger in scale and sharper in outline. Recent scientific evidence has reinforced, and in some cases exceeded, our worst fears. It has given us a picture of the physical impacts on our world that we can expect as our climate changes. And those impacts go far beyond the environmental. Their consequences reach to the very heart of the security agenda.

- The consequences of flooding, disease and famine and from that migration on an unprecedented scale.
- The consequences of drought and crop-failure and from that intensified competition for food, water and energy.
- The consequences of economic disruption on the scale predicted in the Stern Report and not seen since the end of World War II.

Charged as we are with the maintenance of international peace and security, this Council can make a unique contribution in the building of a shared understanding of what an unstable climate will mean for our individual and collective security.

We can and, I believe, we must. Because this Council deals, day in day out, with those very kinds of tensions and conflicts that an unstable climate will make yet more frequent and even more dangerous. As a group of the most respected retired US Admirals and Generals said in a report published just yesterday climate change is a 'threat multiplier for instability'.

Listening to the debate, I am struck by the widespread recognition that there are significant links - already being experienced by some countries - between the impacts to be expected from climate change and the increased risk of conflict and insecurity within and between states.
The UK fully agrees that full account should be taken of climate risks as we address the root causes of conflict. Like other members of the Council, I welcome the Secretary General's offer to assist us in this.

The fact that so many non-members of the Security Council have chosen to speak today is a reflection of the bitter truth that that instability will often be visited first and hardest on the already most vulnerable.

President Museveni of Uganda, whose economy depends on hydropower from a reservoir that is already depleted by drought, has called climate change an act of aggression by the rich against the poor. He is one of the first leaders to see this problem in security terms. He will not be the last. Climate change is a security issue: but it not a matter of narrow national security - it has a new dimension. This is about our collective security in a fragile and increasingly interdependent world. The UK proposed this debate during its Presidency because we felt that, by facing up to the implications of climate change for that collective security, the world will take wiser decisions as we begin to build a low carbon, global economy. Not at the cost of development but to enable us to build a new model of sustainable development.

Of course - as a number of colleagues have said - other organs of the United Nations have particular responsibilities in respect of climate change. But this is not a question of either/or. The UK would welcome substantial debates in the UN General Assembly and the Economic and Social

Council - indeed I made this issue and its effect on security a particular feature of my own address to the General Assembly last September. And I am very well aware that the focus of the Commission on Social Development this year will be energy.

This debate has already shown that climate change is not just an issue of grave concern - but of common concern.

So I judge that we need to embark upon a shared endeavour. If it succeeds, we will all enjoy a better prospect of security: climate change is a threat that can bring us together if we are wise enough to stop it from driving us apart.

The CHAIRMAN. Would it be possible for you to answer a couple of questions from the committee?

Mrs. BECKETT. Sure.

The CHAIRMAN. Great.

Let me just ask you how you found the British public's understanding of the security implications of global warming and whether or not it helped to inform the discussion of policy solutions in your country?

Mrs. BECKETT. I think the people understand the issue. What they don't understand yet is the urgency. There is a tendency to assume this will be a problem for our children, so that makes it a moral dilemma but not necessarily the recognition of the fact that it can be a problem for us within 5, 10, 20 years. Again, perhaps a better recognition of the impact on migration, but on some of the other issues, although every day, as the resource crunch continues, concern about food insecurity, water insecurity, energy insecurity is increasing.

The CHAIRMAN. Well, let me turn and recognize the ranking Republican on the committee, Mr. Sensenbrenner, from Wisconsin.

Mr. SENSENBRENNER. Thank you very much, Madam Foreign Minister.

As you may know, I have somewhat of a skeptical view of this entire issue, and I am deeply concerned about the impacts on the economies and on the people of some of the changes that have been proposed.

You may recall at this time the European Commission reduced the cap on carbon emissions for EU countries, including the United Kingdom. Shortly thereafter, the Times of London ran a story that said that this will cost the British electric generating industry approximately 6 billion British pounds, or 12 billion USD, per year in order to buy the carbon offset credits necessary.

Of course, all of this would end up being passed on to ratepayers and consumers of electricity.

Furthermore, this story indicated that about two-thirds of the credits would be purchased outside the European Union.

This is not a free lunch, and I am wondering what the British government is proposing to help residential ratepayers, particularly those on fixed incomes, to pay for this huge increase in the cost of electricity that they are going to need to light their homes and maybe even heat them.

Mrs. BECKETT. I think everybody would share your concern if it was believed that in the round there would be a very damaging and only a damaging economic impact.

You picked up, quite rightly, on the increase in energy and costs. The British government already does give extra help, particularly to the least well off, to the elderly and the most vulnerable, and is looking all the time at how much more can be done and when it can be done.

But I think I would suggest that although, for those who like me are believers in the science, it would be much more difficult if we believe that the net impact, the overall impact would just be damaging. But we, many of us, believe that, in fact, if you look at the position in the round there are advantages as well as disadvantages.

Let me give you a specific example. It is now very much predicted that ice in the Arctic will disappear faster than anyone had imagined. That can cause problems, but also, of course, it could create new trade passages. It could free up the availability of greater resources. One of the challenges for the world community is to try to see the availability, for example, of those trade routes, of those resources doesn't feed conflict and instability by trying to encourage international cooperation.

So, yes, of course, there will be some damaging impacts, but there are huge opportunities to, not least for those who are the first movers in the industries, in the technological developments that would be required.

Mr. SENSENBRENNER. That is 6 billion pounds of higher electricity cost and in a country the size of the United Kingdom is a lot of money. It is going to impact on people who are the least likely to pay the most if, all of a sudden, next month's electricity bill will be two or three times their current electricity bill. Is the government prepared to have a welfare program that is that vast in order to prevent people like this from, frankly, going broke or freezing during the winter?

Mrs. BECKETT. Well, as I said, Mr. Sensenbrenner, the government does, in fact, have such a program, although I no longer speak for the government.

But can I add that, yes, there is an impact on the costs of the electricity companies. Those same companies have made equally similarly large sums of money over the last several years in terms of extra profits. There is much discussion about how they can work with the government to help those who are most vulnerable.

So that is constantly kept under review, and that will always be the case in every country. I assure you I am as conscious of the need to get re-elected as any politician. So, yes, of course, we recognize the impact, but there is another side to the coin, which is not always recognized.

Mr. SENSENBRENNER. Thank you.

The CHAIRMAN. The gentleman's time is expired.

If you don't mind, the other members of the committee, we will just recognize members for 2 minutes for questions from Mrs. Beckett. I know she has to leave, and we could still accommodate the other witnesses on this panel.

The Chair recognizes the gentlelady from California, Ms. Eshoo.

Ms. ESHOO. Thank you, Mrs. Beckett, for joining us. I think that you not only honor us but you grace this very important hearing. We all want to salute you for the incredible role that you have played and the contributions that you have made. I just couldn't mean that more, and I am so delighted that you are with us today.

As a former Secretary and now as Chair of the Parliament's Intelligence Community, you have been the principal user of national intelligence, as well as being responsible for its oversight. Today, as you know, we are examining the marriage, the bringing together of national security and the whole issue of climate change. Can you tell us what sort of information or judgments related to climate change do policymakers need from their intelligence services?

I am sure you have already heard and picked up on the diminishment of even bringing the two together, that we have so many

other things to do in the world. And this tinkering around with whether temperatures go up or down and perhaps some inexact parts of the science, we need to leapfrog over this stuff and really get to important things.

Can you comment on that and kind of fill in the blank as to what you think, what sort of information or judgments we need to bring about in the cooperation of the international community's Intelligence Communities?

Mrs. BECKETT. I think the main thing that can be contributed by the international community's Intelligence Communities at present is in the area of analysis.

I understand. I sympathize very much with those who say, there are lots of important challenges. Is this so immediate?

All I can tell you is that it is factored into the work. The analysis of what the governments believe are the problems they are going to face, the analysis of what they are likely to do in order to begin to address those problems.

For example, I heard mention of India. I am told that India has begun to construct an 8-foot fence along their border with Bangladesh, no doubt partly as matter of a concern about migration.

The department I previously headed, the Department of Agriculture, has worked for a long time with the Chinese government about the threats to their food supply that climate change poses. This is a huge issue. As the Chinese ambassador who said to me, many years ago, when you are the leader of China, the first thing you think in the morning is can I feed my people today? Because if you can't, you are in serious difficulty.

This kind of understanding is factored into the work and the analysis of our Intelligence Committee; and, for example, our foreign policy order planners in the Ministry of Defense and in the front office are working now on an assessment of impact in the Arctic, which I believe they are hoping to share with your own community, perhaps in the autumn.

Similarly, they are thinking about the impact in the Arabian peninsula, huge implications there, not least in the Nile Valley, Nile delta of sea-level rise, salination and so on, all things that are likely to lead to pressures on the economies as well as——

Ms. ESHOO. Thank you very much.

The CHAIRMAN. We thank you.

The gentleman from California, Mr. Issa.

Mr. ISSA. Thank you.

Madam Chairman, I appreciate your testimony here today; and I will try to be very, very brief in my questions and make them British-centric.

When we talk about the problem, we will accept that it is going to happen if we don't stop putting CO_2 into our atmosphere. Based on that, Europe has led the way in nuclear increases in nuclear energy, while the United States has not built a new one since 1979.

First, how would you caution us on the fact that currently the vast majority of our energy is produced by CO_2-emitting systems, 51 percent of which is coal?

Secondly, and this is much more directed to Great Britain, you are presently an oil-exporting country, essentially exporting carbon knowing that it will be outcast throughout the world.

One, do you think that Great Britain should take a role by only using domestic oil and, in fact, not exporting North Sea oil?

Last but not least, in the alternative, if you still wanted to export it, don't you think you have a responsibility to pay cap and trade on, in fact, the export of that carbon, knowing that it is going to be put into the atmosphere?

Mrs. BECKETT. Well, insofar as there is a cap-and-trade system in the world, the UK will participate in it.

With regard to using just our own oil, I am no expert, but I understand that for many countries and many uses it is a mixture of oils that is required, and it is not always possible simply to source everything domestically no matter how much oil you have.

And I understand your point about dependence, for example, on coal. One of the technologies which we would like to see not just developed, but used, is carbon capture and storage, where work is going on in the UK, in the European Union and, I understand, in the United States.

Mr. ISSA. I appreciate that, Madam Chair, but you said you had to deal with this in 5 to 10 years. In 5 to 10 years, developing science can't be an answer. What would you do today to reduce the size of the carbon footprint of your own country and ours?

Mrs. BECKETT. The biggest thing that we could do is to increase our energy efficiency. If you look, for example, at what Japan has achieved, that is a tremendous step forward. Equally, we are—and I believe the government is likely to make a statement soon—we are likely to put greater input into renewables.

I understand your point about nuclear energy, but of course, although the British Government is committed to that expansion, that itself will take some 15, 20 years or so. So energy efficiency and renewables are very much the way for us at this moment in time.

Mr. ISSA. Thank you, Madam Chair.

Thank you, Mr. Chair.

Mrs. BECKETT. Thank you. I have to go, I fear, sir. I think all politicians understand the pressures of the vote and the whips.

The CHAIRMAN. We are honored that you were able to spend the time with us that you have so far. And your contributions globally to understanding of this issue and giving us political leadership is something that we respect very greatly here in the United States; and we thank you.

And we understand——

Mrs. BECKETT. Thank you very much.

The CHAIRMAN [continuing]. The pressures that you are under.

Mrs. BECKETT. Thank you. It has been an honor. I am sorry I couldn't spend longer with you.

The CHAIRMAN. Thank you.

The Chair recognizes now the gentleman from New Jersey for the purposes of recognizing one of his constituents.

Mr. HOLT. Thank you, Chairman Markey and Chair Eshoo. I appreciate your yielding the floor to me to present to you retired Vice Admiral Paul Gaffney. Madam Chair, Mr. Chair, you could not find someone better qualified to testify today and share wisdom on this subject. Retired Vice Admiral Gaffney has had a career applying science and technology to our Nation's security, as Chief of Naval

Research, as Commander of the Naval Research Lab, as a distinguished oceanographer, as a charter member relative to this subject of MEDEA, applying national technical means to understanding our Earth and its climate, and as a member of the CNA study on national security and climate change.

I also think you will appreciate Admiral Gaffney's scientific approach to this issue. And I must say I am delighted to see him here today, to welcome someone who contributes so much to our national security, but also to the general welfare of New Jersey.

The CHAIRMAN. We thank you.

Why don't you begin your testimony, Admiral Gaffney, and then we will recognize the other witnesses as well.

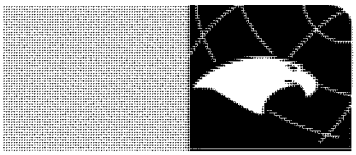
STATEMENT OF VICE ADMIRAL PAUL G. GAFFNEY (RET.), PRESIDENT, MONMOUTH UNIVERSITY, WEST LONG BRANCH, NEW JERSEY

Admiral GAFFNEY. Chairman Markey, Chairwoman Eshoo, my Congressman, Congressman Holt, thank you, sir, very much—he does so many great things for our university—and members of the committee, thanks for the opportunity to appear this morning.

I have submitted formal testimony, and I will just try to summarize by discussing first, just briefly, the 2007 CNA report on the threat of climate change to national security; and then to opine, give you my opinion on the value of leveraging defense and intelligence capabilities and data to both better measure the progress, or even the nonprogress, of global climate change, and to inform climate change policy and planning, especially security planning. Let me start with the CNA part.

I was a member of the military advisory board that sat with the CNA as it developed its report. And I would like to submit that report for the record; I think you have all seen it maybe for months.

[The information follows:]



NATIONAL SECURITY AND THE THREAT OF CLIMATE CHANGE

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Major General Charles "Charlie" Wald, USAF (Ret.)

General Anthony C. Zinni, USMC (Ret.)

To the reader,

During our decades of experience in the U.S. military, we have addressed many national security challenges, from containment and deterrence of the Soviet nuclear threat during the Cold War to terrorism and extremism in recent years.

Global climate change presents a new and very different type of national security challenge.

Over many months and meetings, we met with some of the world's leading climate scientists, business leaders, and others studying climate change. We viewed their work through the lens of our military experience as warfighters, planners, and leaders. Our discussions have been lively, informative, and very sobering.

Carbon dioxide levels in the atmosphere are greater now than at any time in the past 650,000 years, and average global temperature has continued a steady rise. This rise presents the prospect of significant climate change, and while uncertainty exists and debate continues regarding the science and future extent of projected climate changes, the trends are clear.

The nature and pace of climate changes being observed today and the consequences projected by the consensus scientific opinion are grave and pose equally grave implications for our national security. Moving beyond the arguments of cause and effect, it is important that the U.S. military begin planning to address these potentially devastating effects. The consequences of climate change can affect the organization, training, equipping, and planning of the military services. The U.S. military has a clear obligation to determine the potential impacts of climate change on its ability to execute its missions in support of national security objectives.

Climate change can act as a threat multiplier for instability in some of the most volatile regions of the world, and it presents significant national security challenges for the United States. Accordingly, it is appropriate to start now to help mitigate the severity of some of these emergent challenges. The decision to act should be made soon in order to plan prudently for the nation's security. The increasing risks from climate change should be addressed now because they will almost certainly get worse if we delay.

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We thank the following persons for briefing the Military Advisory Board: Dr. James Hansen, lead climate scientist and director, NASA Goddard Institute for Space Studies; Dr. Anthony Janetos of the H. John Heinz III Center for Science, Economics and the Environment; Dr. Richard Moss, senior director, Climate and Energy, United Nations Foundation, formerly director of the U.S. Global Change Research Program Office; Mr. Justin Mundy, senior advisor to the Special Representative on Climate Change, UK Foreign and Commonwealth Office; Maj. Gen. Richard Engel, USAF (Ret.), deputy national intelligence officer for science and technology, National Intelligence Council; Mr. Randy Overbey, former president, Alcoa Primary Metals Development; Mr. Kenneth Colburn, of the Center for Climate Strategies; and Dr. Robert Socolow of Princeton University.

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EXECUTIVE SUMMARY

The purpose of this study is to examine the national security consequences of climate change. A dozen of the nation's most respected retired admirals and generals have served as a Military Advisory Board to study how climate change could affect our nation's security over the next 30 to 40 years—the time frame for developing new military capabilities.

The specific questions addressed in this report are:

1. What conditions are climate changes likely to produce around the world that would represent security risks to the United States?
2. What are the ways in which these conditions may affect America's national security interests?
3. What actions should the nation take to address the national security consequences of climate change?

The Military Advisory Board hopes these findings will contribute to the call President Bush made in his 2007 State of the Union address to "...help us to confront the serious challenge of global climate change" by contributing a new voice and perspective to the issue.

FINDINGS

Projected climate change poses a serious threat to America's national security.
The predicted effects of climate change over the coming decades include extreme weather events, drought, flooding, sea level rise, retreating glaciers, habitat shifts, and the increased spread of life-threatening diseases. These conditions have the potential to disrupt our way of life and to force changes in the way we keep ourselves safe and secure.

In the national and international security environment, climate change threatens to add new hostile and stressing factors. On the simplest level, it has the potential to create sustained natural and humanitarian disasters on a scale far beyond those we see today. The consequences will likely foster political instability where societal demands exceed the capacity of governments to cope.

Climate change acts as a threat multiplier for instability in some of the most volatile regions of the world. Projected climate change will seriously exacerbate already marginal living standards in many Asian, African, and Middle Eastern nations, causing widespread political instability and the likelihood of failed states.

Unlike most conventional security threats that involve a single entity acting in specific ways and points in time, climate change has the potential to result in multiple chronic conditions, occurring globally within the same time frame. Economic and environmental conditions in already fragile areas will further erode as food production declines, diseases increase, clean water becomes increasingly scarce, and large populations move in search of resources. Weakened and failing governments, with an already thin margin for survival, foster the conditions for internal conflicts, extremism, and movement toward increased authoritarianism and radical ideologies.

The U.S. may be drawn more frequently into these situations, either alone or with allies, to help provide stability before conditions worsen and are exploited by extremists. The U.S. may also be called upon to undertake stability and reconstruction efforts once a conflict has begun, to avert further disaster and reconstitute a stable environment.

Projected climate change will add to tensions even in stable regions of the world. The U.S. and Europe may experience mounting pressure to accept large numbers of immigrant and refugee populations as drought increases and food production declines in Latin America and Africa. Extreme weather events and natural disasters, as the U.S. experienced with Hurricane Katrina, may lead to increased missions for a number of U.S. agencies, including state and local governments, the Department of Homeland Security, and our already stretched military, including our Guard and Reserve forces.

Climate change, national security, and energy dependence are a related set of global challenges. As President Bush noted in his 2007 State of the Union speech, dependence on foreign oil leaves us more vulnerable to hostile regimes and terrorists, and clean domestic energy alternatives help us confront the serious challenge of global climate change. Because the issues are linked, solutions to one affect the other. Technologies that improve energy efficiency also reduce carbon intensity and carbon emissions.

RECOMMENDATIONS OF THE MILITARY ADVISORY BOARD:

1. The national security consequences of climate change should be fully integrated into national security and national defense strategies.

As military leaders, we know we cannot wait for certainty. Failing to act because a warning isn't precise enough is unacceptable. The intelligence community should incorporate climate consequences into its National Intelligence Estimate. The National Security Strategy should directly address the threat of climate change to our national security interests. The National Security Strategy and National Defense Strategy should include appropriate guidance to military planners to assess risks to current and future missions caused by projected climate change. The next Quadrennial Defense Review should examine the capabilities of the U.S. military to respond to the consequences of climate change, in particular, preparedness for natural disasters from extreme weather events, pandemic disease events, and other related missions.

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

Managing the security impacts of climate change requires two approaches: mitigating the effects we can control and adapting to those we cannot. The U.S. should become a more constructive partner with the international community to help build and execute a plan to prevent destabilizing effects from climate change, including setting targets for long term reductions in greenhouse gas emissions.

3. The U.S. should commit to global partnerships that help less developed nations build the capacity and resiliency to better manage climate impacts.

As President Bush noted in his State of the Union speech, "Our work in the world is also based on a timeless truth: To whom much is given, much is required." Climate forecasts indicate countries least able to adapt to the consequences of climate change are those that will be the most affected. The U.S. government should use its many instruments of national influence, including its regional commanders, to assist nations at risk build the capacity and resiliency to better cope with the effects of climate change. Doing so now can help avert humanitarian disasters later.

4. The Department of Defense 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.

Numerous Department of Defense studies have found that combat forces would be more capable and less vulnerable by significantly reducing their fuel demand. Unfortunately, many of their recommendations have yet to be implemented. Doing so would have the added benefit of reducing greenhouse gas emissions.

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

Many critical defense installations are located on the coast, and several strategically important ones are on low-lying Pacific islands. Sea level rise and storm surges will threaten these facilities. Planning and action can make these installations more resilient. Lack of planning can compromise them or cause them to be inundated, compromising military readiness and capability.

ABOUT THE REPORT

To better inform U.S. policymakers and the public about the threats to national security from global climate change, the CNA Corporation, a nonprofit national security analysis organization, convened a panel of retired senior military officers and national security experts and conducted an assessment of the national security implications of global climate change. In this context, we define national security to refer to the influence of climate change on geo-strategic balances and world events that could likely involve U.S. military forces or otherwise affect U.S. strategic interests anywhere in the world.

The Military Advisory Board consisted of retired flag and general officers from all four services, including service chiefs and some who served as regional combatant commanders (a regional combatant commander is a four-star officer who commands all U.S. forces in a given region of the world). The Military Advisory Board and the study team received briefings from the U.S. intelligence community, climate scientists, and business and state leaders. They also traveled to the United Kingdom to meet with high-level government and business leaders to learn what actions the United Kingdom is taking to address the threat of climate change. Members of the Military Advisory Board also presented their own views, based on experience, of the security effects of climate change on various regions of the world.

This report documents the results of that effort. We start with a discussion of the geo-strategic implications of climate change in the general sense—that is, how climate change can foster instability and affect international security. We then apply this background to address specific regional security challenges in Africa, Asia, the Middle East, Europe, and the Americas. That is followed by a discussion of the challenges from climate change that can have a direct impact on military systems and operations. We conclude with a set of findings and recommendations related to mitigation, adaptation, and preparation—specific actions the U.S. government should take in response to the challenges presented by climate change. Appendices provide background on members of the Military Advisory Board, and very briefly summarize the science of climate change and ways in which the earth's environment may potentially change.

CLIMATE CHANGE AND THE SCOPE OF THIS STUDY

Although there is a great deal of agreement among the world's climate scientists regarding the overall picture of a changing climate, there is also some disagreement about the extent of future changes.

Regardless of this continuing discussion, the board's view is quite clear: The potential consequences of climate change are so significant that the prudent course of action is to begin now to assess how these changes may potentially affect our national security, and what courses of action, if any, our nation should take.

This approach shows how a military leader's perspective often differs from the perspectives of scientists, policymakers, or the media. Military leaders see a range of estimates and tend not to see it as a stark disagreement, but as evidence of varying degrees of risk. They don't see the range of possibilities as justification for inaction. Risk is at the heart of their job: They

VOICES OF EXPERIENCE

GENERAL GORDON R. SULLIVAN, USA (Ret.)

Chairman, Military Advisory Board | Former Chief of Staff, U.S. Army

ON RISK

Former U.S. Army Chief of Staff Gordon Sullivan enjoys a good debate. But he also knows there are times when debate must stop and action must begin. With respect to climate change, he says that time has arrived.

"We seem to be standing by and, frankly, asking for perfectness in science," Gen. Sullivan said. "People are saying they want to be convinced, perfectly. They want to know the climate science projections with 100 percent certainty. Well, we know a great deal, and even with that, there is still uncertainty. But the trend line is very clear."

"We never have 100 percent certainty," he said. "We never have it. If you wait until you have 100 percent certainty, something bad is going to happen on the battlefield. That's something we know. You have to act with incomplete information. You have to act based on the trend line. You have to act on your intuition sometimes."

> "We never have 100 percent certainty. We never have it. If you wait until you have 100 percent certainty, something bad is going to happen on the battlefield."

In discussing how military leaders manage risk, Gen. Sullivan noted that significant attention is often given to the low probability/high consequence events. These events rarely occur but can have devastating consequences if they do. American families are familiar with these calculations. Serious injury in an auto accident is, for most families, a low probability/high consequence event. It may be unlikely, but we do all we can to avoid it.

During the Cold War, much of America's defense efforts focused on preventing a Soviet missile attack—the very definition of a low probability/high consequence event. Our effort to avoid such an unlikely event was a central organizing principle for our diplomatic and military strategies.

When asked to compare the risks of climate change with those of the Cold War, Gen. Sullivan said, "The Cold War was a specter, but climate change is inevitable. If we keep on with business as usual, we will reach a point where some of the worst effects are inevitable."

"If we don't act, this looks more like a high probability/high consequence scenario," he added.

Gen. Sullivan shifted from risk assessment to risk management.

"In the Cold War, there was a concerted effort by all leadership—political and military, national and international—to avoid a potential conflict," he said. "I think it was well known in military circles that we had to do everything in our power to create an environment where the national command authority—the president and his senior advisers—were not forced to make choices regarding the use of nuclear weapons.

"The situation, for much of the Cold War, was stable," Gen. Sullivan continued. "And the challenge was to keep it stable, to stop the catastrophic event from happening. We spent billions on that strategy.

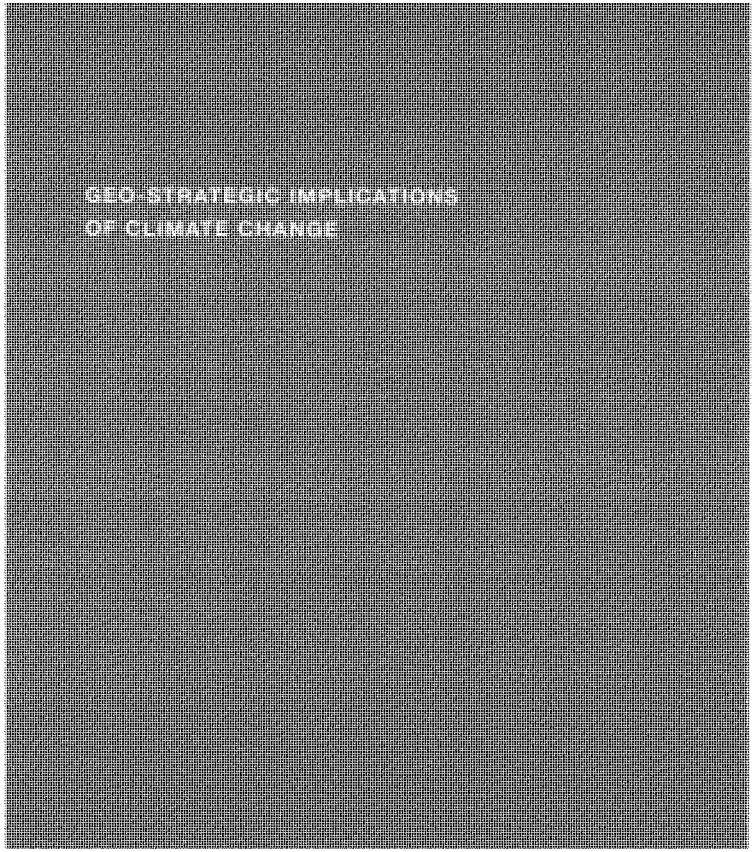
"Climate change is exactly the opposite. We have a catastrophic event that appears to be inevitable. And the challenge is to stabilize things—to stabilize carbon in the atmosphere. Back then, the challenge was to stop a particular action. Now, the challenge is to inspire a particular action. We have to act if we're to avoid the worst effects."

assess and manage the many risks to America's security. Climate change, from the Military Advisory Board's perspective, presents significant risks to America's national security. Before explaining some of those risks, we touch on an important scientific point.

A global average temperature increase of 1.3°F (plus or minus 0.3°F) occurred over the twentieth century. But the temperature change on its own is not what shapes this security assessment. Rather, it is the impact that temperature increases can have on natural systems, including:

- Habitats
- Precipitation patterns
- Extreme weather events
- Ice cover
- Sea level

Throughout this report, we do not attempt to tie our findings regarding security implications to any one particular projection of future temperature changes, precipitation changes, or sea level rise whether due to ocean expansion or ice sheet breakup. Rather, our goal is to articulate the possible security implications of climate change and to consider mitigating steps the nation could take as part of an overall national security plan.



GEO-STRATEGIC IMPLICATIONS OF CLIMATE CHANGE

One reason human civilizations have grown and flourished over the last five millennia is that the world's climate has been relatively stable. However, when climates change significantly or environmental conditions deteriorate to the point that necessary resources are not available, societies can become stressed, sometimes to the point of collapse [1].

For those concerned about national security, stability is a primary goal. Maintaining stability within and among nations is often a means of avoiding full-scale military conflicts. Conversely, instability in key areas can threaten our security. For these reasons, a great deal of our national security efforts in the post-World War II era have been focused on protecting stability where it exists and trying to instill it where it does not.

This brings us to the connection between climate change and national security.

As noted, climate change involves much more than temperature increases. It can bring with it many of the kinds of changes in natural systems that have introduced instability among nations throughout the centuries.

In this chapter, we consider some of the ways climate change can be expected to introduce the conditions for social destabilization. The sources of tension and conflict we discuss here are certainly not solely due to climate change; they have been discussed by the national security community for many years. However, climate change can exacerbate many of them [2]. For example:

- Some nations may have impaired access to food and water.
- Violent weather, and perhaps land loss due to rising sea levels and increased storm surges, can damage infrastructure and uproot large numbers of people.
- These changes, and others, may create large number of migrants. When people cross borders in search of resources, tensions can arise.

When climates change significantly or environmental conditions deteriorate to the point that necessary resources are not available, societies can become stressed, sometimes to the point of collapse.

- Many governments, even some that look stable today, may be unable to deal with these new stresses. When governments are ineffective, extremism can gain a foothold.
- While the developed world will be far better equipped to deal with the effects of climate change, some of the poorest regions may be affected most. This gap can potentially provide an avenue for extremist ideologies and create the conditions for terrorism.

THE DESTABILIZING IMPACTS OF CLIMATE CHANGE

REDUCED ACCESS TO FRESH WATER

Adequate supplies of fresh water for drinking, irrigation, and sanitation are the most basic prerequisite for human habitation. Changes in rainfall, snowfall, snowmelt, and glacial melt have significant effects on fresh water supplies, and climate change is likely to affect all of those things. In some areas of the Middle East, tensions over water already exist.

Mountain glaciers are an especially threatened source of fresh water [3]. A modest rise in temperature of about 2° to 4°F in mountainous

VOICES OF EXPERIENCE

VICE ADMIRAL RICHARD H. TRULY, USN (Ret.)

Former NASA Administrator, Shuttle Astronaut and the first Commander of the Naval Space Command

ON DRAWING HIS OWN CONCLUSIONS

Retired Vice Adm. Richard H. Truly was a space shuttle commander and NASA administrator and is a member of the National Academy of Engineering. When he began service as director of the Department of Energy's National Renewable Energy Laboratory in 1997, he reminded his staff that he would be confronted with a new set of issues.

"I told them that I was unencumbered with experience or knowledge of the energy business, and that I would need their help," Adm. Truly said. "I had a pretty steep learning curve."

One of the first issues he was asked to consider was the extent to which fossil fuel emissions were affecting the climate.

"I wasn't convinced by a person or any interest group—it was the data that got me."

"I was a total agnostic," Truly said. "I had spent most of my life in the space and aeronautics world, and hadn't really wrestled with this. I was open-minded."

"Over the course of the next few years, I started really paying attention to the data. When I looked at what energy we had used over the past couple of centuries and what was in the atmosphere today, I knew there had to be a connection. I wasn't convinced by a person or any interest group—it was the data that got me. As I looked at it on my own, I couldn't come to any other conclusion. Once I got past that point, I was utterly convinced of this connection between the burning of fossil fuels and climate change. And I was convinced that if we didn't do something about this, we would be in deep trouble."

Adm. Truly noted an ironic twist about his path to this conclusion. "I was NASA administrator when Jim Hansen was first talking about these issues," he said, referring to NASA's top climate scientist. "But I was focused elsewhere then, and I should have listened more closely. I didn't become a convert until I saw the data on my own."

"The stresses that climate change will put on our national security will be different than any we've dealt with in the past. For one thing, unlike the challenges that we are used to dealing with, these will come upon us extremely slowly, but come they will, and they will be grinding and inexorable. But maybe more challenging is that they will affect every nation, and all simultaneously. 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."

When asked about his experience twenty-five years ago in space, and how it affects him today, Adm. Truly said, "It does change you, there's no doubt about it. I have images burned in my mind that will never go away—images of the earth and its fragility. I was a test pilot. I was an aviator. I was not an environmentalist. But I do love the natural environment, and seeing the earth from space was the experience that I return to when I think about what we know now about the climate."

"One of the things that struck me on my first day in space is that there is no blue sky. It's something that every human lives with on Earth, but when you're in space, you don't see it. It looks like there's nothing between you and the surface of the earth. And out beyond that, it looks like midnight, with only deep black and stars."

"But when you look at the earth's horizon, you see an incredibly beautiful, but very, very thin line. You can see a tiny rainbow of color. That thin line is our atmosphere. And the real fragility of our atmosphere is that there's so little of it."

regions can dramatically alter the precipitation mix by increasing the share falling as rain while decreasing the share falling as snow. The result is more flooding during the rainy season, a shrinking snow/ice mass, and less snowmelt to feed rivers during the dry season [4]. Forty percent of the world's population derives at least half of its drinking water from the summer melt of mountain glaciers, but these glaciers are shrinking and some could disappear within decades. Several of Asia's major rivers—the Indus, Ganges, Mekong, Yangtze, and Yellow—originate in the Himalayas [4]. If the massive snow/ice sheet in the Himalayas—the third-largest ice sheet in the world, after those in Antarctic and Greenland—continues to melt, it will dramatically reduce the water supply of much of Asia.

Most countries in the Middle East and northern Africa are already considered water scarce, and the International Water Resource Management Institute projects that by 2025, Pakistan, South Africa, and large parts of India and China will also be water scarce [5]. To put this in perspective: the U.S. would have to suffer a decrease in water supply that produces an 80 percent decrease in per capita water consumption to reach the United Nations definition of "water scarce." These projections do not factor in climate change, which is expected to exacerbate water problems in many areas.

IMPAIRED FOOD PRODUCTION

Access to vital resources, primarily food and water, can be an additional causative factor of conflicts, a number of which are playing out today in Africa. Probably the best known is the conflict in Darfur between herders and farmers. Long periods of drought resulted in the loss of both farmland and grazing land to the desert. The failure of their grazing lands compelled the nomads to migrate southward in search of water and herding ground, and that in turn led to conflict with the farming tribes occupying those lands. Coupled with population growth, tribal, ethnic, and religious differences, the competition for land turned violent. Probably more than any other recent conflict, Darfur provides

In some areas of the Middle East, tensions over water already exist.

a case study of how existing marginal situations can be exacerbated beyond the tipping point by climate-related factors. It also shows how lack of essential resources threatens not only individuals and their communities but also the region and the international community at large.

Worldwide food production will be affected by climate change in a variety of ways. Crop ecologists estimate that for every 1.8°F rise in temperature above historical norms, grain production will drop 10 percent [6].

Most of the world's growth in food demand is occurring on the Indian subcontinent and in sub-Saharan Africa, areas already facing food shortages [6]. Over the coming decades, these areas are expected to become hotter and drier [7].

HEALTH CATASTROPHES

Climate change is likely to have major implications for human health. While some impacts, such as reduced deaths from cold temperatures in some areas, will be positive, the World Health Organization estimates that the overall impact will be negative [8].

The major concern is significant spreading of the conditions for vector-borne diseases, such as dengue fever and malaria, and food-borne diseases, such as salmonellosis [8]. The decline in available fresh water in some regions will also have an impact, as good health and adequate supplies of clean water are inextricably linked.

A health emergency involving large numbers of casualties and deaths from disease can quickly expand into a major regional or global security

challenge that may require military support, ranging from distribution of vaccines to full-scale stability operations [9].

LAND LOSS AND FLOODING: DISPLACEMENT OF MAJOR POPULATIONS

About two-thirds of the world's population lives near coastlines [10], where critically important facilities and infrastructure, such as transportation routes, industrial facilities, port facilities, and energy production and distribution facilities are located. A rise in sea level means potential loss of land and displacement of large numbers of people. Even in our own nation, Hurricane Katrina showed the social upheaval and tensions that can result from land loss and displaced populations. But while the impact of inundation from one-time occurrences such as Hurricane Katrina is temporary, even as it is devastating, inundation from climate change is likely to be permanent on the scale of human lifetimes. Rising sea levels will also make coastal areas more vulnerable to flooding and land loss through erosion.

Storm surges will also take a greater toll on coastal communities and infrastructure as sea levels rise. According to a Pacific Institute study, a six-inch rise in the water level of San Francisco Bay would mean a fairly routine one-in-ten-year storm would wreak as much damage as a far more serious "hundred-year storm" would have caused before the sea level rise [11]. In the U.S., we may be able to cope with such a change, but poorer nations would be greatly challenged.

Most of the economically important major rivers and river deltas in the world—the Niger, the Mekong, the Yangtze, the Ganges, the Nile, the Rhine, and the Mississippi—are densely populated along their banks. As sea levels rise and storm surges increase, saline water can contaminate groundwater, inundate river deltas and valleys, and destroy croplands.

SECURITY CONSEQUENCES OF THESE DESTABILIZING EFFECTS

GREATER POTENTIAL FOR FAILED STATES AND THE GROWTH OF TERRORISM

Many developing countries do not have the government and social infrastructures in place to cope with the types of stressors that could be brought on by global climate change.

When a government can no longer deliver services to its people, ensure domestic order, and protect the nation's borders from invasion, conditions are ripe for turmoil, extremism and terrorism to fill the vacuum. Lebanon's experience with the terrorist group Hezbollah and the Brazilian government's attempts to reign in the slum gang First Capital Command [12] are both examples of how the central governments' inability to provide basic services has led to strengthening of these extra-governmental entities.

MASS MIGRATIONS ADD TO GLOBAL TENSIONS

The reasons for mass migrations are very complex. However, when water or food supplies shift or when conditions otherwise deteriorate (as from sea level rise, for example), people will likely move to find more favorable conditions [13]. Although climate change may force migrations of workers due to economic conditions, the greatest concern will be movement of asylum seekers and refugees who due to ecological devastation become settlers:

- By 2025, 40 percent of the world's population will be living in countries experiencing significant water shortages [14].
- Over the course of this century, sea level rise could potentially cause the displacement of tens of millions of people from low-lying areas such as Bangladesh [15].

Migrations in themselves do not necessarily have negative effects, although taken in the context of global climate change a net benefit is highly unlikely. Three types of migration patterns occur.

VOICES OF EXPERIENCE

ADMIRAL T. JOSEPH LOPEZ, USN (Ret.)

Former Commander-in-Chief, U.S. Naval Forces Europe and of Allied Forces, Southern Europe

ON CLIMATE CHANGE AND THE CONDITIONS FOR TERRORISM

Some Americans believe we don't need to worry about climate change for decades. They say the issue isn't as urgent as the war on terror. Adm. Lopez, the retired top NATO commander in Bosnia, has a different take. He sees a strong connection between the two.

"Climate change will provide the conditions that will extend the war on terror," Adm. Lopez said.

"You have very real changes in natural systems that are most likely to happen in regions of the world that are already fertile ground for extremism," Adm. Lopez said. "Droughts, violent weather, ruined agricultural lands—those are the kinds of stresses we'll see more of under climate change."

Those changes in nature will lead to changes in society. "More poverty, more forced migrations, higher unemployment. Those conditions are ripe for extremists and terrorists."

In the controversial war on terrorism, Adm. Lopez noted, there is general agreement on at least one thing: It's best to stop terrorism before it develops. "In the long term, we want to address the underlying conditions that terrorists seek to exploit. That's what we'd like to do, and it's a consensus issue—we all want to do that. But climate change prolongs those conditions, it makes them worse."

"Dealing with instability and how you mitigate that leads to questions about the role U.S. security forces can play," Adm. Lopez added. "What can we do to alleviate the problems of instability in advance? And keep in mind this will all be under a challenged resource situation. This is very complicated. Of course, the military can be a catalyst for making this happen, but it can't do it all. This is also about economics, politics, and diplomacy.

"In the military, we've often run into problems associated with what we call 'stovepipes,' where each branch of the service has its own way of doing things. And we've learned that stovepipes don't work well. We have to take the same approach with our government, to ensure that the many agencies are working together. In those cases where we do get involved, the task should not automatically be the responsibility of the U.S. military."

He also described other layers of complexity. Even in those cases where the U.S. may choose to embrace such a role, the best solutions may require a nongovernmental component. "If you don't include economists or far-thinking, out-of-the-box business people in this, you'll get shortchanged." He also said the U.S. "can't imply that we'll do this all alone. We need to make sure we don't give that impression. The same forces of economics, business, politics, diplomacy, and military and security interests can function to build coalitions in order to maintain stability when challenged by dramatic climate change."

> "Climate change will provide the conditions that will extend the war on terror."

The greatest concern will be movement of asylum seekers and refugees who due to ecological devastation become settlers...

Some migrations take place within countries, adding to a nation's political stress, causing economic upheaval—positive and negative—and distracting from other issues. As a developed nation, the U.S. was able to absorb the displacement of people from the Gulf Coast in the wake of Hurricane Katrina without suffering economic or political collapse, but not without considerable turmoil.

Some migrations cross international borders. Environmental degradation can fuel migrations in less developed countries, and these migrations can lead to international political conflict. For example, the large migration from Bangladesh to India in the second half of the last century was due largely to loss of arable land, among other environmental factors. This affected the economy and political situation in the regions of India that absorbed most of this population shift and resulted in violence between natives and migrants [16].

A third form of migration involves not only crossing international borders but moving across vast regions while doing so. Since the 1960s, Europe has experienced this kind of "south to north" migration, with an influx of immigrants from Africa and Asia. The shift in demographics has created racial and religious tensions in many European countries, as evidenced in the 2005 civil unrest in France.

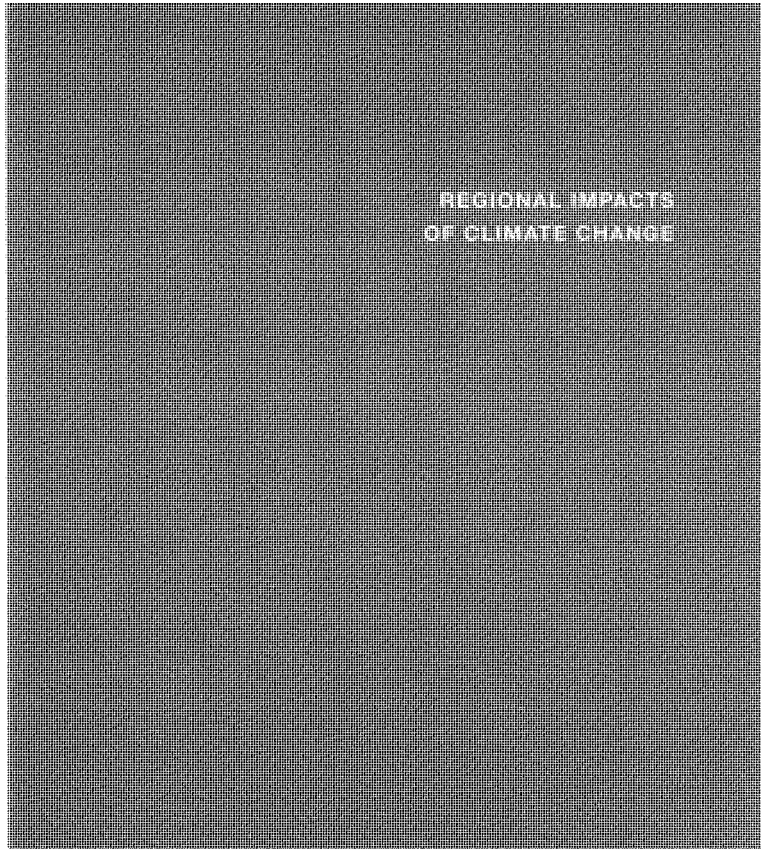
POTENTIAL ESCALATION OF CONFLICTS OVER RESOURCES

To live in stability, human societies need access to certain fundamental resources, the most important of which are water and food. The lack, or mismanagement, of these resources can undercut the stability of local populations; it can affect regions on a national or international scale.

Disputes over key resources such as water do not automatically trigger violent outcomes, and no recent wars have been waged solely over water resources. In areas with a strong government and societal cohesiveness, even tense disputes and resource crises can be peacefully overcome. In fact, in recent years, arguments have been made that multinational cooperation over precious water resources has been more an instrument of regional peace than of war [17].

Nevertheless, resource scarcity always has the potential to be a contributing factor to conflict and instability in areas with weak and weakly supported governments [19]. In addition, there is always the potential for regional fighting to spread to a national or international scale. Some recent examples include: the 1994 genocide in Rwanda that was furthered by violence over agricultural resources; the situation in Darfur, Sudan, which had land resources at its root and which is increasingly spilling over into neighboring Chad; the 1970s downfall of Ethiopian Emperor Haile Selassie through his government's inability to respond to food shortages; and the 1974 Nigerian coup that resulted largely from an insufficient response to famine [19].

Whether resource scarcity proves to be the impetus for peaceful cooperation or an instigator of conflict in the future remains to be seen. Regions that are already water scarce (such as Kuwait, Jordan, Israel, Rwanda, Somalia, Algeria, and Kenya) may be forced to confront this choice as climate change exacerbates their water scarcity.



REGIONAL IMPACTS OF CLIMATE CHANGE

AFRICA

VULNERABLE TO CLIMATE CHANGE IMPACTS

Africa's importance to U.S. national security can no longer be ignored. Indeed, with the recent establishment of a U.S. African Command, the U.S. has underscored Africa's strategic importance. Its weak governments and the rising presence of terrorist groups make Africa important to the fight against terrorism. Moreover, Africa is also of strategic value to the U.S. as a supplier of energy: by 2015, it will supply 25 to 40 percent of our oil, and it will also be a supplier of strategic minerals such as chrome, platinum, and manganese.

Such changes will add significantly to existing tensions and can facilitate weakened governance, economic collapses, massive human migrations, and potential conflicts.

Reductions in soil moisture and further loss of arable land may be the most significant of the projected impacts of climate change in Africa. At the same time, extreme weather events are likely to increase. These expected changes portend reduced supplies of potable water and food production in key areas. Such changes will add significantly to existing tensions and can facilitate weakened governance, economic collapses, massive human migrations, and potential conflicts. In Somalia, for example, alternating droughts and floods led to migrations of varying size and speed and prolonged the instability on which warlords capitalized.

Increased political instability in Africa potentially adds additional security requirements for the U.S. in a number of ways. Stability operations, ranging from humanitarian direct delivery of goods and the protection of relief workers, to the establishment of a stable and reconstructed state, can place heavy demands on the U.S. military. While the nature of future stability operations is a matter of speculation, historically some stability operations have involved significant military operations and casualties. Political instability also makes access to African trade and resources, on which the U.S. is reliant for both military and civilian uses, a riskier proposition.

UNSTABLE GOVERNMENTS AND TERRORIST HAVENS

Africa is increasingly crucial in the ongoing battle against civil strife, genocide, and terrorism. Numerous African countries and regions already suffer from varying degrees of famine and civil strife. Darfur, Ethiopia, Eritrea, Somalia, Angola, Nigeria, Cameroon, Western Sahara—all have been hit hard by tensions that can be traced in part to environmental causes. Struggles that appear to be tribal, sectarian, or nationalist in nature are often triggered by reduced water supplies or reductions in agricultural productivity.

The challenges Africa will face as a result of climate change may be massive, and could present serious threats to even the most stable of governments. Many African nations can

VOICES OF EXPERIENCE

GENERAL CHARLES F. "CHUCK" WALD, USAF (Ret.)

Former Deputy Commander, Headquarters U.S. European Command (USEUCOM)

ON CLIMATE CHANGE IN AFRICA

When asked why Americans should be interested in African security issues, retired Air Force Gen. Chuck Wald gave a number of reasons.

"We ought to care about Africa because we're a good country," Gen. Wald said. "We have a humanitarian character; it's one of our great strengths, and we shouldn't deny it. Some may be tempted to avert their eyes, but I would hope we instead see the very real human suffering taking place there. We should be moved by it, challenged by it. Even in the context of security discussions, I think these reasons matter, because part of our security depends on remaining true to our values.

"There are exotic minerals found only in Africa that have essential military and civilian uses," Gen. Wald continued. "We import more oil from Africa than the Middle East—probably a shock to a lot of people—and that share will grow. Africa could become a major exporter of food.

"My view is that we'll be drawn into the politics of Africa, to a much greater extent than in the past. A lot of Americans today would say Africa is an optional engagement. I don't think that's the case, even today, but it certainly won't be in the future."

To show how climate change can worsen conditions that are already quite desperate, Gen. Wald described a trip to Nigeria.

"We landed in Lagos late in the afternoon," Gen. Wald said. "This is a city, now, with roughly 17 million people. The best way to describe our drive from the airport to the hotel is that it reminded me of a 'Mad Max' movie. There were massive numbers of people on the roads, just milling around. There were huge piles of trash. There were fires along the roadside and in the distance—huge fires. It was just short of anarchy.

"That's the situation today. Even in a time of relative stability, there is very little civil governance, and very little ability to serve huge numbers of people with basics like electricity, clean water, health care, or education.

"If you add rising coastal waters and more extreme weather events, you then have millions of people who could be displaced. There really is no controlled place for them to go, no capacity for an organized departure, and no capacity to make new living situations. When you add in the effects of climate change, it adds to the existing confusion and desperation, and puts more pressure on the Nigerian government. It makes the possibility of conflict very real. If the delta is flooded, or if major storms damage their drilling capacity, you lose the primary source of income.

"My view is that we'll be drawn into the politics of Africa, to a much greater extent than we have in the past."

"Culturally, you have a country that is split geographically between Muslims and Christians. If migrations occur, you put real pressure on that country. It's already tense and fragile. When you exacerbate that situation with climate change effects, it's not hard to postulate on the dangers."

best be described as failed states, and many African regions are largely ungoverned by civil institutions. When the conditions for failed states increase—as they most likely will over the coming decades—the chaos that results can be an incubator of civil strife, genocide, and the growth of terrorism.

LESS EFFECTIVE GOVERNANCE AND POTENTIAL MIGRATIONS

More than 30 percent of the world's refugees and displaced persons are African. Within the last decade, severe food shortages affected twenty-five African countries and placed as many as 200 million people "on the verge of calamity" [20].

Expected future climate change will exacerbate this problem. The Sahara desert is spreading [21], and the sub-Saharan region is expected to suffer reduced precipitation [22]. As climate changes and agricultural patterns are disrupted, the geopolitics of the future will increasingly be the politics of scarcity. Potential rainfall decreases in North Africa would likely exacerbate the problem of migration to Europe. Reduced rainfall and increasing desertification of the sub-Saharan region will likely also result in migrations to Europe, as well as migrations within the African continent.

> ...the chaos that results can be an incubator of civil strife, genocide, and the growth of terrorism.

LAND LOSS AND WEATHER DISASTERS

Sea level rise could also result in the displacement of large numbers of people on the African continent, as more than 25 percent of the African population lives within 100 kilometers (sixty-two miles) of the coast, and six of Africa's ten largest cities are on the coast. Nigeria and Mozambique are particularly vulnerable to the effects of sea level rise and storm surges. Two cyclones in 2000 displaced 500,000 people in Mozambique and caused 950,000 people to require some form of humanitarian assistance [23]. The Niger Delta accounts for about 7.5 percent of Nigeria's land area and a population of 20 million people.

In light of the potential magnitude of the human crisis that could result from major weather-related natural disasters and the magnitude of the response and recovery efforts that would be required, stability operations carried out by international militaries will likely occur more frequently.

HEALTH CHALLENGES WILL CONTINUE TO ESCALATE

Severe and widespread continental health issues complicate an already extremely volatile environment. Climate change will have both direct and indirect impacts on many diseases endemic to Africa such as malaria and dengue fever [24]. Increases in temperature can expand the latitude and altitude ranges for malaria, and flooding from sea level rise or severe weather events can increase the population of malaria vectors. For example, a temperature rise of 2°F can bring a malaria epidemic to Kenya. Excessive flooding is also conducive to the spread of cholera.

VOICES OF EXPERIENCE

VICE ADMIRAL PAUL G. GAFFNEY II, USN (Ret.)

Former President, National Defense University; Former Chief of Naval Research and Commander, Navy Meteorology and Oceanography Command

ON MILITARY RESEARCH AND CLIMATE SCIENCE

The Department of Defense and the intelligence community have in the past used their immense capability for data collection and analysis to address national and international environmental questions. Retired Vice Adm. Paul G. Gaffney II says we have the capacity to do this again, this time for better understanding and monitoring of climate change.

The DoD offers equipment, talent and, as Adm. Gaffney put it, "Data, data, data."

"You will find the defense and intelligence communities have extraordinary amounts of data, and, if done in a careful and deliberate manner, data collected in the past and into the future can be made available to climate scientists," Adm. Gaffney said. "Be it imagery, other satellite records, data from Navy oceanographic ships and vehicles, surface warships and submarines, or observations collected by aircraft—you can find ways to smooth it to protect what must be protected if the raw data cannot be released. If climate change is, in fact, a critical issue for security, then the military and intelligence communities should be specifically tasked to aggressively find ways to make their data, talent, and systems capabilities available to American efforts in understanding climate change signals.

"Most of our ships are already outfitted to collect basic atmospheric and oceanic information. U.S. military platforms are all over the world, all of the time; they become platforms of opportunity to collect data for this global issue."

Adm. Gaffney also cited staff capabilities.

"The quality of personnel from the defense and intelligence organizations is exceptional," he said. "Within the DoD, we have labs that are as good as any that exist anywhere in the world, using whatever metrics you want—papers published, patents, Nobel laureates.

"Look at the Navy ocean modelers and remote sensing experts. They worked with scientists at NASA's Jet Propulsion Lab to unlock the secrets of El Niño, using space-borne altimetry data and new numerical ocean circulation models. The mission was a military one, but it ultimately played a role in helping us understand more about the climate."

Throughout the Cold War, the U.S. and the Soviet Union each collected data in the Arctic. Ice thickness and sub-ice ocean conditions affecting acoustics were critical security issues.

> "The mission was a military one, but it ultimately played a role in helping us understand more about the climate."

After the breakup of the Soviet Union, many saw that that data could be used to determine temperature and ice condition changes over time. The two sides collaborated on ways to share and reconcile the data, and in 1996 released the Arctic Ocean Atlas to the world's scientific community. The data have advanced understanding of climate change in significant ways.

"I think there's another component to this," said Adm. Gaffney. "Defense employees [military and civilian] actually have a responsibility to the nation when they have a certain skill. They have a responsibility to share that with the public and the nation, as long as security is not compromised. They've done this in the past. And I'd love to see them able to do this more often in the future."

ASIA

CLIMATE CHANGE CAN AFFECT IMPORTANT U.S. STRATEGIC INTERESTS

Most climate projections indicate increasing monsoon variability, resulting in increases in both flood and drought intensity in temperate and tropical Asia [24]. Almost 40 percent of Asia's population of nearly 4 billion lives within forty-five miles of its nearly 130,000-mile-long coastline. Sea level rise, water availability affecting agricultural productivity, and increased effects of infectious disease are the primary climate effects expected to cause problems in Asia.

SEA LEVEL RISE MAY THREATEN MILLIONS

Some of the most vulnerable regions in the world to sea level rise are in southern Asia, along the coasts of Pakistan, India, Sri Lanka, Bangladesh, and Burma; and Southeast Asia, along the coasts between Thailand and Vietnam, including Indonesia and the Philippines.

Asia, where hundreds of millions of people rely on waters from vanishing glaciers on the Tibetan plateau, could be among the hardest hit regions.

Sandy coastlines backed by densely populated, low-lying plains make the Southeast Asian region particularly vulnerable to inundation. Coastal Malaysia, Thailand, and Indonesia could all be threatened with flooding and the loss of important coastal farmlands.

The location and topography of Bangladesh make it one of the most vulnerable countries in the world to a rise in sea level. Situated at the northeastern region of South Asia on the Bay of Bengal, it is about the size of Iowa with a population of almost 150 million. It is very flat and low lying, except in the northeast and southeast regions, and has a coastline exceeding 300 miles. About 10 percent of Bangladesh is within three feet of mean sea level. Over the next century, population rise, land scarcity and frequent flooding coupled with increased storm surge and sea level rise could cause millions of people to cross the border into India. Migration across the border with India is already such a concern that India is building a fence to keep Bangladeshis out.

India and Pakistan have long, densely populated and low-lying coastlines that are very vulnerable to sea level rise and storm surge. Coastal agriculture, infrastructure, and onshore oil exploration are at risk. Possible increases in the frequency and intensity of storm surges could be disproportionately large in heavily developed coastal areas and also in low-income rural areas, particularly such low-lying cities such as Mumbai, Dhaka and Karachi.

WATER STRESS AFFECTS ASIA'S ABILITY TO FEED ITS PEOPLE

By 2050, regions dependent on glacial melting for water may face serious consequences. Asia, where hundreds of millions of people rely on waters from vanishing glaciers on the Tibetan plateau, could be among the hardest hit regions.

Climate change has the potential to exacerbate water resource stresses in most regions of Asia [7]. Most countries in Asia will experience

VOICES OF EXPERIENCE

ADMIRAL JOSEPH W. PRUEHER, USN (Ret.)

Former Commander-in-Chief of the U.S. Pacific Command (PACOM) and Former U.S. Ambassador to China

ON CLIMATE CHANGE IN THE PACIFIC

In a discussion of climate change issues in the Pacific region, retired Adm. Joseph Prueher first considered the issue from a singular perspective: the impact climate change may have on the region's governments and their relative stability.

Using Singapore as an example, he said, "It's a democracy, but with a very strong leadership. They've prospered, but owing to lack of space they have many restrictions we do not have. If one looks ahead to the effects of climate change, you start with the understanding that Singapore, low lying and very hot, will face more storms and more moisture. It will face coastal impacts. Those kinds of changes, in a crowded nation, create a whole set of issues that affect not just the economy and culture, but the security dynamic as well."

Adm. Prueher then shifted the conversation to the region's governments in general.

"It may well be that in very crowded nations, a stronger government is necessary in order to avoid instability," he said. "In Asia, one sees a whole line of countries with governments exercising very firm control. But when you look to the future to consider the kinds of impacts we may see—flooding, extreme weather events, real disruptions—you also have to consider some steps that we in the U.S. would think offensive. Those are steps these governments may feel they need to take in order to avoid chaos."

Referencing low-lying regions where arable land will be lost, he said, "You see mass destruction in countries where the government is not robust. When people can't cope, governing structures break down."

Adm. Prueher noted that how a government responds presents a new set of issues for American political and military leaders.

"Most of our security forces are for protecting our nation from outside, but that's not necessarily the case in the rest of the world," Adm. Prueher said. "Military personnel elsewhere are often directed internally. They focus on keeping internal order. There might be cases where the U.S. military might be in a position to help deal with the effects of climate change—with floods or the migrations that might result from them. The immediate goal would be to relieve suffering, not to preserve governments. But if you're partnering with a nation's army keeping domestic order, that can be a real challenge."

When asked about China, Adm. Prueher noted that the European Union is working to identify ways of cooperating with the Chinese on the development of clean coal technologies. And he cautioned against those in the U.S. who oppose any kind of technology exchange with China.

"Yes, China is focused heavily on growth. Yes, there is what I think is a quite remote possibility of future military conflict. And, yes, it is a real challenge to negotiate with them; one can count on them to negotiate toward what they perceive to be their own national interest," he said. "Reasonable enough. But on the issue of carbon emissions, it doesn't help us to solve our problem if China doesn't solve theirs. And that means we need to engage them on many fronts. Issues of great importance to our world will not get solved without U.S.-Chinese cooperation. I happen to like dealing with the Chinese. You may not, or you may be suspicious of them, but we need to cooperate.

"They have 1.3 billion people, 200 million of whom are under-employed or unemployed," Adm. Prueher said. "They have a great deal of pride and see themselves as a great nation. Most of what we say to enhance environmental progress in China is seen by them as a way to stop them from continuing economic growth.

"Not talking to the Chinese is not an option."

VOICES OF EXPERIENCE

LIEUTENANT GENERAL LAWRENCE P. FARRELL JR., USAF (Ret.)

Former Deputy Chief of Staff for Plans and Programs, Headquarters U.S. Air Force

ON CLIMATE, ENERGY AND BATTLEFIELD READINESS

Retired Air Force Lt. Gen. Larry Farrell sees a great deal of uncertainty about climate change and appears willing to engage any credible scientist in discussions of discrepancies among climate models.

"You might say I'm from Missouri on this issue—you have to show me," he said. "And there is still much uncertainty and debate on this issue." Despite this, Gen. Farrell sees indications that some change is occurring.

"Clearly, there has been some warming over the past 100 years and some climate change. These changes have been accompanied by fairly significant increases in the greenhouse gases carbon dioxide and methane. If there is a connection between warming trends and greenhouse gases, our use of energy may be playing a part in this. If these trends continue into the future, the changes could well exacerbate existing social and political instabilities and create new ones. The military has the obligation to assess the potential military implications of these trends." Gen. Farrell's preference is to focus on solutions.

"If you advocate intelligent energy solutions, you'll solve this problem," Gen. Farrell said, before walking through a long list of reasons for a focus on energy.

A key concern for Gen. Farrell: battlefield readiness.

"Seventy percent of the tonnage on the battlefield is fuel," he said. "That's an amazing number. Between fuel and water, it's almost everything we take to the battlefield. Food and ammo are really quite small in comparison.

"Delivering that fuel requires secure lines of communication," Gen. Farrell said. "If you have bases nearby, you may be able to deliver it with much less risk, but that's a supply line issue. And we see in Iraq how dangerous it can be to transport fuel.

"The military should be interested in fuel economy on the battlefield," he said. "It's a readiness issue. If you can move your men and materiel more quickly, if you have less tonnage but the same level of protection and firepower, you're more efficient on the battlefield. That's a life and death issue."

Gen. Farrell talked about the challenge of focusing on long-term issues.

"Climate change is not something people can recognize," he said. "In geologic times, it's quick. But in human terms, it's still very slow. It's hard to get all of us to do something about it. And that leads me to believe we should deal with other things that are a problem today but that also get us to the heart of climate change. That's where I get to the issue of smart energy choices.

"Focus on conservation and on energy sources that aren't based in carbon. Move toward a hydrogen economy, in part because you know it will ultimately give you efficiency and, yes, profit. When you pursue these things, you build alliances along the way. That's safety. It's a benefit we see right now."

He suggested another reason as well: There are military impacts that come from our energy use.

"We're forced to be interested in parts of the world because of our energy consumption," he said. "Solving the energy problem solves a real security problem. You get to choose your points of engagement. It's like one of the things your grandmother told you, 'Don't go looking for trouble. If you find trouble, you have to deal with it—but don't go looking for it!' Well, when we go looking for oil, we're really looking for trouble."

substantial declines in agricultural productivity because of higher temperatures and more variable rainfall patterns [25]. Net cereal production in South Asia, for example, is projected to decline by 4 to 10 percent by the end of this century under the most conservative climate change projections.

But the problem isn't just water scarcity—too much water can also be a problem. By 2050, snow melting in the high Himalayas and increased precipitation across northern India are likely to produce flooding, especially in catchments on the western side of the Himalayas, in northern India, Nepal, Bangladesh, and Pakistan.

RISING SPREAD OF INFECTIOUS DISEASE

Climate change is expected to increase the geographic range of infectious diseases such as malaria, dengue fever, and schistosomiasis and increase the risk of water-borne disease. Climate projections indicate the Asia/Pacific region as a whole is likely to become warmer and wetter in the coming decades, creating conditions more conducive to disease vectors such as mosquitoes. With the exception of east central China and the highlands of west China, much of the Asia/Pacific region is exposed to malaria and dengue or has conditions suitable for their spread. This region will continue to be a hot spot for these diseases in the decades ahead, with certain regions becoming more prone to epidemics.

EUROPE

THREATENED BY CLIMATE PROBLEMS FROM OTHER PARTS OF THE WORLD

Europe is getting warmer overall, northern Europe is getting wetter, and southern Europe is getting drier. (For the purposes of this report, Europe includes the western part of the former Soviet Union.)

The developed nations of Europe will likely be able to deal with the direct climate changes expected for that region, but some of the less developed nations (the Balkans, for instance) might be stressed. Europe has already experienced extreme weather events that herald potential climate change effects: the more than 35,000 deaths associated with the heat wave of 2003 are a reminder of the vulnerability of all nations to climate extremes [26]. However, the major impact on Europe from global climate change is likely to be migrations, now from the Maghreb (Northern Africa) and Turkey, and increasingly, as climate conditions worsen, from Africa.

With its shortages of water, the Mediterranean area could experience considerable strain.

DIRECT IMPACTS: HOTTER TEMPERATURES AND RISING SEAS

Most of Europe has experienced surface air temperature increases during the twentieth century (1.44°F on average), with the largest increases over northwest Russia and the Iberian Peninsula. Temperatures in Europe since 1990 have been the warmest since records have been kept. More heat waves across all of Europe are likely to increase stress on human health and could produce an increased risk of malaria and dengue fever in southern Europe. Agricultural zones would move north, and the Mediterranean regions, especially in Spain, would suffer a greater loss of productivity.

Precipitation is expected to increase in the north but decrease in the central and eastern Mediterranean zones and south Russia, with acute water shortages projected in the Mediterranean area, especially in the summer.

MITIGATION AND ADAPTATION TO CLIMATE CHANGE IN EUROPE

The capacity for adaptation to these changes is very high in most of prosperous, industrial Europe, but less so in lesser-developed places like the Balkans, Moldova, and the Caucasus. With its shortages of water, the Mediterranean area could experience considerable strain. In northern Europe, countries may build higher dikes, as they have done in the past, but at a certain point that may not be sufficient, and much port and other coastal infrastructure would have to be moved further inland, at great expense. Some northern migration within Europe might be expected—the Italians already face a large Albanian immigration, and others may press north from the Balkans.

THE PRIMARY STRATEGIC CONCERN OF EUROPEANS: MASSIVE MIGRATIONS TO EUROPE

The greater threat to Europe lies in migration of people from across the Mediterranean, from the Maghreb, the Middle East, and sub-Saharan Africa. Environmental stresses and climate change are certainly not the only factors driving migrations to Europe. However, as more people migrate from the Middle East because of water shortages and loss of their already marginal agricultural lands (as, for instance, if the Nile Delta disappears under the rising sea level), the social and economic stress on European nations will rise.

It is possible that Europeans, given their long and proximate association with the sub-Saharan African countries, may undertake more stability operations, as they have in Sierra Leone and Côte d'Ivoire. Their militaries, and in particular their navies and coast guards, would also have to increase their activities in securing their borders and in intercepting migrants moving by sea, as is now going on through the Canary Islands.

MIDDLE EAST

ABUNDANT OIL, SCARCE WATER AND INTERNATIONAL CONFLICT

The Middle East has always been associated with two natural resources, oil (because of its abundance) and water (because of its scarcity). The Persian Gulf contains more than half (57 percent) of the world's oil reserves, and about 45 percent of the world's natural gas reserves. And because its production costs are among the world's lowest, the Persian Gulf region is likely to remain the world's largest oil exporter for the foreseeable future. At the end of 2003, Persian Gulf countries produced about 32 percent of the world's oil. Because of its enormous oil endowment, the Middle East is one of the most strategically significant regions of the world. The security impacts of climate change on the Middle East are greatly magnified by its historical and current levels of international conflict, and competition for increasingly scarce resources may exacerbate the level of conflict. This is the region of the world in which the U.S. is most engaged militarily.

WATER: INCREASING STRESS ON AN EXISTING SHORTAGE

In this region, water resources are a critical issue; throughout history, cultures here have flourished around particular water sources. With the population explosion underway, water will become even more critical. Of the countries in the Middle East, only Egypt, Iran, and Turkey have abundant fresh water resources. Roughly two-thirds of the Arab world depends on sources outside their borders for water. The most direct effect of climate change to be felt in the Middle East will be a reduction in precipitation. But the change will not be uniform across the region.

The flows of the Jordan and Yarmuk rivers are likely to be reduced, leading to significant water stress in Israel and Jordan, where water demand already exceeds supply. Exacerbation of water shortages in those two countries and in Oman, Egypt, Iran, and Iraq are likely to threaten conventional crop production, and salinization of coastal aquifers could further threaten agriculture in those regions.

SEA LEVEL RISE

Sea level rise combined with increased water demand from growing populations are likely to exacerbate saltwater intrusion into coastal fresh water aquifers, already a considerable problem for the Gaza Strip. Salinization of coastal aquifers could further threaten agriculture in these regions. Additional loss of arable land and decreases in food security could encourage migration within the Middle East and Africa, and from the Middle East to Europe and elsewhere.

INFLAMING A REGION OF POLITICAL INSTABILITY

Climate change has the potential to exacerbate tensions over water as precipitation patterns change, declining by as much as 60 percent in some areas. In addition, the region already suffers from fragile governments and infrastructures, and as a result is susceptible to natural disasters. Overlaying this is a long history of animosity among countries and religious groups. With most of the world's oil being in the Middle East and the industrialized and industrializing nations competing for this resource, the potential for escalating tensions, economic disruption, and armed conflict is great.

VOICES OF EXPERIENCE

GENERAL ANTHONY C. "TONY" ZINNI, USMC (Ret.)

Former Commander-in-Chief of U.S. Central Command (CENTCOM)

ON CLIMATE CHANGE, INSTABILITY AND TERRORISM

A starting point in understanding this connection might be to "look at how climate change effects could drive populations to migrate," Gen. Zinni said. "Where do these people move? And what kinds of conflicts might result from their migration? You see this in Africa today with the flow of migrations. It becomes difficult for the neighboring countries. It can be a huge burden for the host country, and that burden becomes greater if the international community is overwhelmed by these occurrences.

"You may also have a population that is traumatized by an event or a change in conditions triggered by climate change," Gen. Zinni said. "If the government there is not able to cope with the effects, and if other institutions are unable to cope, then you can be faced with a collapsing state. And these end up as breeding grounds for instability, for insurgencies, for warlords. You start to see real extremism. These places act like Petri dishes for extremism and for terrorist networks."

In describing the Middle East, the former CENTCOM commander said, "The existing situation makes this place more susceptible to problems. Even small changes may have a greater impact here than they may have elsewhere. You already have great tension over water. These are cultures often built around a single source of water. So any stresses on the rivers and aquifers can be a source of conflict. If you consider land loss, the Nile Delta region is the most fertile ground in Egypt. Any losses there could cause a real problem, again because the region is already so fragile. You have mass migrations within the region, going on for many decades now, and they have been very destabilizing politically."

Gen. Zinni referenced the inevitability of climate change, with global temperatures sure to increase. But he also stressed that the intensity of those changes could be reduced if the U.S. helps lead the way to a global reduction in carbon emissions. He urged action now, even if the costs of action seem high.

> "It's not hard to make the connection between climate change and instability, or climate change and terrorism."

"We will pay for this one way or another," he said. "We will pay to reduce greenhouse gas emissions today, and we'll have to take an economic hit of some kind. Or we will pay the price later in military terms. And that will involve human lives. There will be a human toll.

"There is no way out of this that does not have real costs attached to it. That has to hit home."

THE WESTERN HEMISPHERE

RISKS FOR THE UNITED STATES AND OUR NEIGHBORS

Latin America includes some very poor nations in Central America and in the Caribbean, and their ability to cope with a changing climate will present challenges for them and thus for the U.S. Global climate change can lead to greater intensity of hurricanes as sea surface temperatures rise, with enormous implications for the southeastern U.S., Central America, and Caribbean nations. Loss of glaciers will strain water supply in several areas, particularly Peru and Venezuela. Rising sea levels will threaten all coastal nations. Caribbean nations are especially vulnerable in this regard, with the combination of rising sea levels and increased hurricane activity potentially devastating to some island nations.

The primary security threats to the U.S. arise from the potential demand for humanitarian aid and a likely increase in immigration from neighbor states. It is important to remember that the U.S. will be dealing with its own climate change issues at the same time.

INCREASING WATER SCARCITY AND GLACIAL MELT

The melting of glaciers at an accelerated rate in Venezuela and the Peruvian Andes is a particular concern because of the direct reliance on these glaciers for water supplies and hydroelectric power. The Peruvian plains, northeast Brazil, and Mexico, already subject to drought, will find that droughts in the future will last longer. That would lead to further land degradation and loss of food production—a blow to Latin America, which is particularly dependent on food production for subsistence, and to Brazil, whose economy is fueled by food exports.

Drought and decreased rainfall is projected to also affect the central southern U.S. That could have significant impact on food production and sources of water for millions. The High Plains (or "Ogallala") aquifer underlies much of the semi-arid west-central U.S. The aquifer provides water for 27 percent of the irrigated land in the country and supplies about 30 percent of the groundwater used for irrigation. In fact, three of the top grain-producing states—Texas, Kansas, and Nebraska—each get 70 to 90 percent of their irrigation water from the Ogallala aquifer [27]. Human-induced stresses on this groundwater have resulted in water-table declines greater than 100 feet in some areas [28]. This already difficult situation could be greatly exacerbated by a decrease in rainfall predicted for the region. Similarly, a recent study by the National Research Council on the Colorado River basin (the river is the main water source for tens of millions of people in the Southwest) predicted substantial decreases in river flow, based on higher population coupled with the climate change affects [29].

STORMS AND SEA LEVEL RISE

In looking at the relationship between warmer temperatures and storm intensity, a panel convened by the World Meteorological Organization concluded: "It is likely that some increase in tropical cyclone peak wind-speed and rainfall

ADMIRAL DONALD L. "DON" PILLING, USN (Ret.)

Former Vice Chief of Naval Operations

ON OPERATIONAL CHALLENGES OF CLIMATE CHANGE

Retired Adm. Donald L. Pilling, former vice chief of naval operations, highlighted one of the reasons government agencies have been slow to respond to the issue of climate change.

"One of the problems in talking about this issue is that no one can give you a date by which many of the worst effects will be occurring," Adm. Pilling said. "If it's 2050, there isn't a guy in uniform today who will be wearing a uniform then. The Pentagon talks about future year plans that are six years down the road."

Still, Adm. Pilling was able to talk about the issue and the planning challenges it might offer. He enumerated a list of operational impacts, starting with the assumption that there would be increased instances of large migrations—people fleeing homelands that have felt the impacts of climate changes.

"This is key because it's easy to see how our allies can be consumed by this," Adm. Pilling said. "They won't have time to participate in exercises at sea because all of their assets will be focused on protecting the border and beaches. Europe will be focused on its own borders. There is potential for fracturing some very strong alliances based on migrations and the lack of control over borders.

"Open seas at the Arctic means you have another side of this continent exposed," he said. "Between the Canadians and us, there are a handful of ships oriented for the northernmost latitudes. But there is not much flexibility or depth there."

He said that an increase in the frequency or intensity of hurricanes could have a destabilizing effect on maintenance and the stability of ships and fleets. "It may cause you to move ships north to avoid hurricanes. If a ship's captain thinks he's in the middle of hurricane season, he's going to go out—get away from port. It impacts maintenance schedules and impacts operational structures. And that doesn't factor in the damage that hurricanes can do to our ports and maintenance facilities. We spent a few billion to restore Pascagoula after Hurricane Katrina—and we're not done yet. But at least that's an impact you can see. People can get their hands around that."

> "There is potential for fracturing some very strong alliances based on migrations and the lack of control over borders."

Over time, some of the operational issues related to climate change would be increasingly difficult to resolve.

"At headquarters, they would need to be much more thoughtful about investment decisions," he said. "Why invest significant resources in bases that are in low-lying regions? Why invest in bases that may continue to be flooded? Those are tough questions to ask, but I'd ask them."

will occur if the climate continues to warm. Model studies and theory project a 3-5% increase in wind-speed per degree Celsius increase of tropical sea surface temperatures" [30]. Warming seas and their link to storm energy are especially worrisome for Central American and small Caribbean island nations that do not have the social infrastructure to deal with natural disasters.

Flooding could increase with sea level rises, especially in the low-lying areas of North America—inundation models from the University of Arizona project that a sea level rise of three feet would cause much of Miami, Fort Myers, a large portion of the Everglades, and all of the Florida Keys to disappear [31].

In the past, U.S. military forces have responded to natural disasters, and are likely to continue doing so in the foreseeable future [32]. The military was deployed to Central America after Hurricane Mitch in 1998 and to Haiti following the rains and mudslides of 2004. The U.S. military was also heavily involved in the response to Hurricane Katrina. Climate change will likely increase calls for this type of mission in the Americas in the future.

INCREASED MIGRATION/REFUGEE FLOWS INTO THE U.S.

The greater problem for the U.S. may be an increased flow of migrants northward into the U.S. Already, a large volume of south to north migration in the Americas is straining some states and is the subject of national debate. The migration is now largely driven by economics and political instability. The rate of immigration from Mexico to the U.S. is likely to rise because the water situation in Mexico is already marginal and could worsen with less rainfall and more droughts. Increases in weather disasters, such as hurricanes elsewhere, will also stimulate migrations to the U.S. [32].

VOICES OF EXPERIENCE

GENERAL PAUL J. KERN, USA (Ret.)

Former Commanding General, U.S. Army Materiel Command

ON WEATHER, LOGISTICS, AND THE CAUSES OF WAR

In 1989, Gen. Kern commanded a brigade based at Fort Stewart, Georgia, and was preparing to send men and materiel to Turkey in advance of NATO training exercises. Those plans were interrupted by Hurricane Hugo, which appeared headed to Savannah, the port of departure for the mission.

"We were all ready to go, but the ships involved in transport had to be sent to Norfolk," Gen. Kern said. "So we broke down the shipments that had already been assembled for delivery. We then moved our aviation assets out, and moved base families into shelters. Ultimately, the hurricane hit Charleston, and did major damage to the airbase there. That meant one of my military battalions was deployed to Charleston to help with the recovery there."

"These weren't immense challenges for us—they were things we could handle," Gen. Kern said. "But the planned training exercises—preparing us for our core military mission—were not as good as they could have been. It's a very subtle thing, but there you have it in a nutshell: Extreme weather can affect your readiness."

Looking ahead, Gen. Kern, now retired from active duty, discussed wider global trends that the military must address to achieve an optimal state of readiness. He believes "the critical factors for economic and security stability in the twenty-first century are energy, water, and the environment. These three factors need to be balanced for people to achieve a reasonable quality of life. When they are not in balance, people live in poverty, suffer high death rates, or move toward armed conflict."

The need for water illustrates the consequences of imbalance. "When water is scarce, people move until they can find adequate supply," he said. "As climate change causes shifts in accessibility to water, we observe large movements of refugees and emigration."

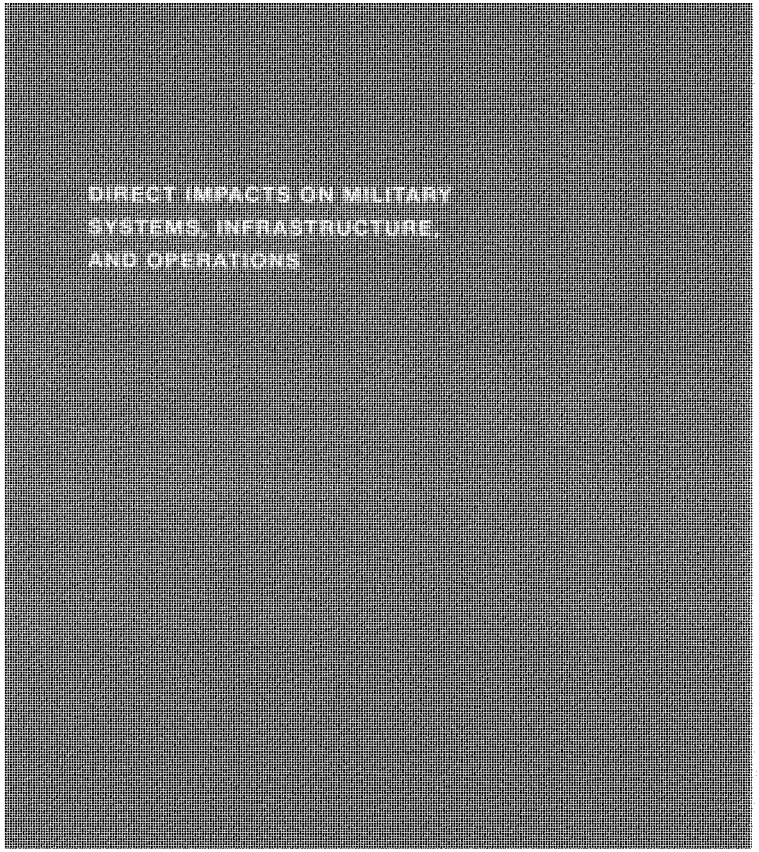
He said Africa offers prime examples of this, and referenced a passage from the book Transboundary Rivers, Sovereignty and Development (Anthony Turton, Peter Ashton, and Eugene Cloete, eds.), which states that "there is a vast and growing literature that cites water as a likely cause of wars in the twenty-first century, and the 15 international basins in the Southern African Development Community (SADC) are regularly named as points of tension, second only to the arid and hostile Middle East."

He quoted from a letter written to him by Anthony Turton, a soldier in the war over the Okavong River basin, who wrote that "to serve one's country on the field of battle is truly noble, but to serve as a peace-builder is truly great." Turton also wrote that in his new role of restoring river basins, he has "found personal peace."

Gen. Kern also cited the late Nobel Laureate, Dr. Rick Smalley, of Rice University, who often lectured on the world's top 10 problems. Smalley listed energy, water, food, and the environment at the top of his list.

"While the military community has not focused on these issues, we often find ourselves responding to a crisis created by the loss of these staples, or by a conflict over claims to one or more of them," Gen. Kern said. "In my view, therefore, military planning should view climate change as a threat to the balance of energy access, water supplies, and a healthy environment, and it should require a response. Responding after the fact with troops—after a crisis occurs—is one kind of response. Working to delay these changes—to accommodate a balance among these staples—is, of course, another way."

> "Military planning should view climate change as a threat to the balance of energy access, water supplies, and a healthy environment, and it should require a response."



DIRECT IMPACTS ON MILITARY SYSTEMS, INFRASTRUCTURE, AND OPERATIONS

Climate change will stress the U.S. military by affecting weapons systems and platforms, bases, and military operations. It also presents opportunities for constructive engagement.

WEAPONS SYSTEMS AND PLATFORMS

Operating equipment in extreme environmental conditions increases maintenance requirements—at considerable cost—and dramatically reduces the service life of the equipment. In Iraq, for instance, sandstorms have delayed or stopped operations and inflicted tremendous damage to equipment. In the future, climate change—whether hotter, drier, or wetter—will add stress to our weapons systems.

A stormier northern Atlantic would have implications for U.S. naval forces [34]. More storms and rougher seas increase transit times, contribute to equipment fatigue and hamper flight operations. Each time a hurricane approaches the U.S. East Coast, military aircraft move inland and Navy ships leave port. Warmer temperatures in the Middle East could make operations there even more difficult than they are today. A Center for Naval Analyses study showed that the rate at which U.S. carriers could launch aircraft was limited by the endurance of the flight deck crew during extremely hot weather [34].

BASES THREATENED BY RISING SEA LEVELS

During the Cold War, the U.S. established and maintained a large number of bases throughout the world. U.S. bases abroad are situated to provide a worldwide presence and maximize our ability to move aircraft and personnel. Climate change could compromise some of those bases. For example, the highest point of Diego Garcia, an atoll in the southern Indian Ocean that serves as a major logistics hub for U.S. and British forces in the Middle East, is only a few feet above sea level. As sea level rises, facilities there will be lost or will have to relocated. Although the consequences to military readiness are not insurmountable, the loss of some forward bases would require longer range lift and strike capabilities and would increase the military's energy needs.

Closer to home, military bases on the eastern coast of the United States are vulnerable to hurricanes and other extreme weather events. In 1992, Hurricane Andrew ravaged Homestead Air Force Base in Florida so much that it never reopened; in 2004 Hurricane Ivan knocked out Naval Air Station Pensacola for almost a year. Increased storm activity or sea level rise caused by future climate change could threaten or destroy essential base infrastructure. If key military bases are degraded, so, too, may be the readiness of our forces.

> Climate change—whether hotter, drier, or wetter—will add stress to our weapons systems.

MILITARY OPERATIONS

Severe weather has a direct effect on military readiness. Ships and aircraft operations are made more difficult; military personnel themselves must evacuate or seek shelter. As retired

Army Gen. Paul Kern explained of his time dealing with hurricanes in the U.S. Southern Command: "A major weather event becomes a distraction from your ability to focus on and execute your military mission."

In addition, U.S. forces may be required to be more engaged in stability operations in the future as climate change causes more frequent weather disasters such as hurricanes, flash floods, and extended droughts.

THE ARCTIC: A REGION OF PARTICULAR CONCERN

A warming Arctic holds great implications for military operations. The highest levels of planetary warming observed to date have occurred in the Arctic, and projections show the high northern latitudes warming more than any other part of the earth over the coming century. The Arctic, often considered to be the proverbial "canary" in the earth climate system, is showing clear signs of stress [33].

The U.S. Navy is concerned about the retreat and thinning of the ice canopy and its implications for naval operations. A 2001 Navy study concluded that an ice-free Arctic will require an "increased scope of naval operations" [35]. That increased scope of operations will require the Navy to consider weapon system effectiveness and various other factors associated with operating in this environment. Additionally, an Arctic with less sea ice could bring more competition for resources, as well as more commercial and military activity that could further threaten an already fragile ecosystem.

As extreme weather events becomes more common, so do the threats to our national electricity supply.

DEPARTMENT OF DEFENSE ENERGY SUPPLIES ARE VULNERABLE TO EXTREME WEATHER

The DoD is almost completely dependent on electricity from the national grid to power critical missions at fixed installations and on petroleum to sustain combat training and operations. Both sources of energy and their distribution systems are susceptible to damage from extreme weather.

The national electric grid is fragile and can be easily disrupted. Witness the Northeast Blackout of 2003, which was caused by trees falling onto power lines in Ohio. It affected 50 million people in eight states and Canada, took days to restore, and caused a financial loss in the United States estimated to be between $4 billion and $10 billion [36]. People lost water supplies, transportation systems, and communications systems (including Internet and cell phones). Factories shut down, and looting occurred.

As extreme weather events becomes more common, so do the threats to our national electricity supply.

One approach to securing power to DoD installations for critical missions involves a combination of aggressively applying energy efficiency technologies to reduce the critical load (more mission, less energy); deploying renewable energy sources; and "islanding" the installation from the national grid. Islanding allows power generated on the installations to flow two ways—onto the grid when there is excess production and from the grid when the load exceeds local generation. By pursuing these actions to improve resiliency of mission, DoD would become an early adopter of technologies that would help transform the grid, reduce our load, and expand the use of renewable energy.

For deployed systems, the DoD pays a high price for high fuel demand. In Iraq, significant combat forces are dedicated to moving fuel and protecting fuel supply lines. The fuel delivery situation on the ground in Iraq is so limited that that the Army has established a "Power Surety Task Force" to help commanders of forward operating bases cut the number of fuel convoys by using energy more efficiently. Maj. Gen. Richard Zilmer, USMC, commander of the multinational force in the Anbar province of Iraq, asked for help in August 2006. His request was for renewable energy systems. According to Gen. Zilmer, "reducing the military's dependence on fuel for power generation could reduce the number of road-bound convoys … 'Without this solution [renewable energy systems], personnel loss rates are likely to continue at their current rate. Continued casualty accumulation exhibits potential to jeopardize mission success…' " Along a similar vein, Lt. Gen. James Mattis, while commanding general of the First Marine Division during Operation Iraqi Freedom, urged: "Unleash us from the tether of fuel."

Energy-efficiency technologies, energy conservation practices and renewable energy sources are the tools forward bases are using to stem their fuel demand and reduce the "target signature" of their fuel convoys.

Numerous DoD studies dating from the 2001 Defense Science Board report "More Capable Warfighting Through Reduced Fuel Burden" have concluded that high fuel demand by combat forces detracts from our combat capability, makes our forces more vulnerable, diverts combat assets from offense to supply line protection, and increases operating costs. Nowhere are these problems more evident than in Iraq, where every day 2.4 million gallons of fuel is moved through dangerous territory, requiring protection by armored combat vehicles and attack helicopters [37].

DoD planners estimate that it costs $15 to deliver one gallon of fuel from its commercial supplier to the forward edge of the battlefield and about $26 to deliver a gallon of fuel from an airborne tanker, not counting the tanker aircraft cost. Furthermore, DoD's procedures for determining the types of systems it needs do not take these fuel burden considerations into account. DoD should require more efficient combat systems and should include the actual cost of delivering fuel when evaluating the advantages of investments in efficiency [38, 39].

… reducing the military's dependence on fuel for power generation could reduce the number of road-bound convoys …

DoD should have an incentive to accurately account for the cost of moving and protecting fuel and to invest in technologies that will provide combat power more efficiently. Deploying technologies that make our forces more efficient also reduces greenhouse gas emissions. The resulting technologies would make a significant contribution to the vision President Bush expressed in his State of the Union speech when he said, "America is on the verge of technological breakthroughs that will … help us to confront the serious challenge of global climate change."

Given the human and economic cost of delivering fuel to combat forces and the almost total dependence on the electric grid for critical missions, DoD has strong operational economic incentives to aggressively pursue energy efficiency in its combat systems and its installations. By investing at levels commensurate with its interests, DoD would become an early adopter of innovative technologies and could stimulate others to follow.

ENGAGEMENT OPPORTUNITIES

Climate change threats also create opportunities for constructive engagement such as stability operations and capacity building. The U.S. military helped deliver relief to the victims of

the 2005 Indian Ocean tsunami because it is the only institution capable of rapidly delivering personnel and materiel anywhere in the world on relatively short notice. DoD Directive 3000.05, issued in 2006, provides the mandate to conduct military and civilian stability operations in peacetime as well as conflict to maintain order in states and regions. The Combatant Command's Theater Security Cooperation Program, which seeks to engage regional states, could be easily focused on climate change mitigation and executed in concert with other U.S. agencies through U.S. embassy country teams. The objective would be to build the host nation military's capabilities and capacity to support civilian government agencies. It also enhances good governance and promotes stability, making failed states and terrorist incursion less likely. Because many climate change problems cross borders, it could also promote regional communication and cooperation.

If the frequency of natural disasters increases with climate change, future military and political leaders may face hard choices about where and when to engage. Deploying troops affects readiness elsewhere; choosing not to may affect alliances. And providing aid in the aftermath of a catastrophic event or natural disaster can help retain stability in a nation or region, which in turn could head off U.S. military engagement in that region at a later date.

VOICES OF EXPERIENCE

ADMIRAL FRANK "SKIP" BOWMAN, USN (Ret.)

Former Director, Naval Nuclear Propulsion Program; Former Deputy Administrator-Naval Reactors, National Nuclear Security Administration

ON CLIMATE CHANGE, ENERGY, AND NATIONAL SECURITY

Adm. Bowman's more than thirty-eight years of naval service in the nuclear submarine community lead him to these thoughts: "Our nuclear submarines operate in an unforgiving environment. Our Navy has recognized this environment and has mitigated the risk of reactor and undersea operations through a combination of: a) careful selection of motivated, intelligent people whom we train and qualify to the highest standards; b) rigorous quality assurance of component design and manufacturing; c) verbatim compliance with strict rules of operation; d) routine examination of all aspects of reactor and submarine operations; and, e) a constant sharing of the lessons we learn through these processes. These components lead to a defense in depth against a very low probability, but high consequence event. We should begin planning for a similar approach in dealing with potential climate change effects on our national security."

Adm. Bowman notes that today, a raging debate is underway over a potential set of climate-induced global changes that could have a profound impact on America's national security interests. Our Military Advisory Board has heard the arguments, some depicting near-doomsday scenarios of severe weather and oceanic changes exacerbated by man-made emissions of greenhouse gases to our environment, others depicting a much less severe outcome as merely one in many observed cyclic weather patterns over time, with virtually no man-made component.

Adm. Bowman concludes that regardless of the probability of the occurrence, the projected weather-driven global events could be dire and could adversely affect our national security and military options significantly. He therefore argues that the prudent course is to begin planning, as we have in submarine operations, to develop a similar defense in depth that would reduce national security risks even if this is a low probability event, given the potential magnitude of the consequences. He feels that as the debate over cause, effect, and magnitude continues, we in the military should begin now to take action to provide a resilient defense against the effects of severe climate change, not only within our own borders, but also to provide resiliency to those regions of unrest and stress that already are threatening our national security today.

> "Our nuclear submarines operate in an unforgiving environment. Our Navy has recognized this environment and has mitigated the risk. ... We should begin planning for a similar approach in dealing with potential climate change effects on our national security."

The admiral further believes that "our national security is inextricably linked to our country's energy security." Thoughtful national policy is required as we debate a correct course of future energy policy. International participation is necessary for this global issue. Adm. Bowman firmly believes that "energy and economic security—key components of our national security—must be underpinned by alternative forms of energy available indigenously and from countries whose values are not at odds with our own. As our economy and GDP have grown, so have our energy needs. This demand for energy strains available supplies: energy sources used for one purpose, such as electricity generation, are not available for other needs. Natural gas used for electricity is not available as feedstock for many industries that depend on it, like the chemical industry, the fertilizer industry, and the plastics industry. Short-term decisions made over the past decade to build cheap gas generation placed an unsustainable demand on natural gas and has resulted in hundreds of thousands of U.S. jobs moving offshore."

Adm. Bowman warns that this interdependence between energy policy and national security must be viewed over the long haul as the country addresses global climate change. "Coal and nuclear electricity generation remain the obvious choices for new U.S. generation. However, to meet the concerns over measured and measurable increases in CO_2 concentrations in our atmosphere and their potential effect on climate, the country, as a matter of national urgency, must develop the technologies to capture and sequester CO_2 from coal generation. This technology is not available today on a commercial scale, and the lead time for its development is measured in tens of years, not months.

Therefore, Adm. Bowman argues, we should begin developing plans to shore up our own defenses against the potentially serious effects of climate, regardless of the probability of that occurrence, while making more resilient those countries ill-prepared today to deal with that potential due to disease, poor sanitation, lack of clean water, insufficient electricity, and large coastal populations. In doing so, these plans must recognize the interdependency of energy and security.

WEATHER AND WARFARE

An increase in extreme weather can make the most demanding of tasks even more challenging.

Increases in global temperatures will increase the likelihood of extreme weather events, including temperature extremes, precipitation events, and intense tropical cyclone activity [7].

With this in mind, we ask the obvious: How does extreme weather affect warfare?

The impacts are significant. There are countless historical examples of how weather events have affected the outcome of a conflict.

- Typhoons (Divine Wind) twice saved Japan from invasion by Kublai Khan and his Mongol horde.
- North Sea gales badly battered the Spanish Armada in 1588 when Sir Francis Drake defeated it, saving England from invasion.

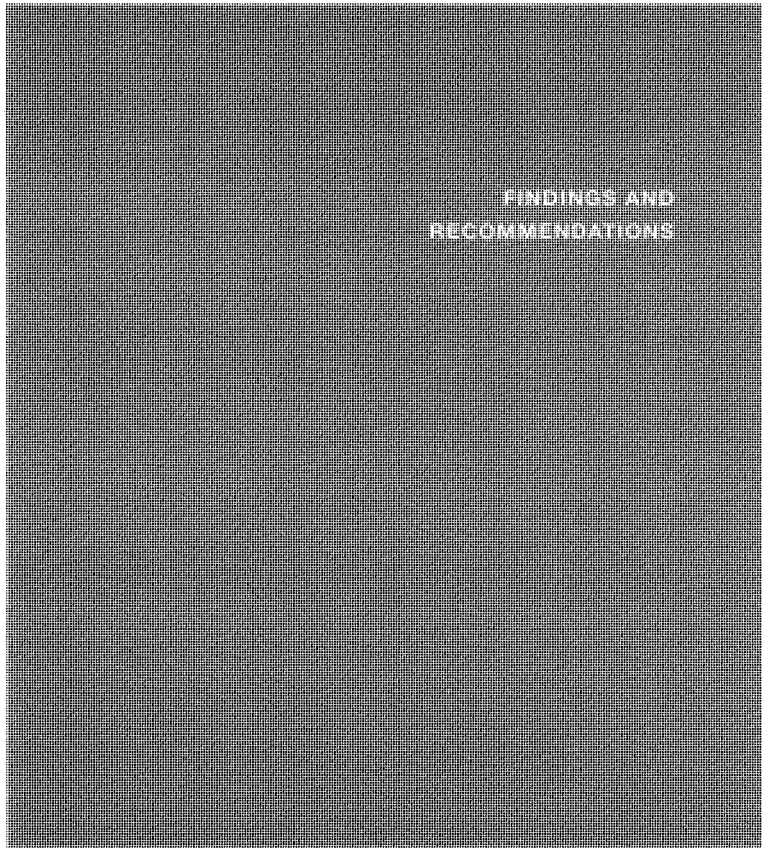
An increase in extreme weather can make the most demanding of tasks even more challenging.

- The severe and unpredictable Russian winter has defeated three invading armies: Charles XII of Sweden in 1708, Napoleon in 1812 and Hitler in 1941.
- During the American Revolution, George Washington would have been surrounded at the Battle of Long Island had adverse winds not prevented the British from landing and cutting him off.
- Hardships from a severe drought in 1788 are thought to be the spark that caused the French Revolution.
- Napoleon was defeated at the Battle of Waterloo in large part because a torrential downpour obscured visibility and delayed the French attack.

Though technology allows us to overcome many obstacles, weather still poses great threats to successful military operations on the land, sea, or in the air.

- During World War II, Typhoon Cobra capsized three destroyers, a dozen more ships were seriously damaged and 793 men died. This natural disaster, called the Navy's worst defeat in open seas in World War II, killed nearly a third as many as in the attack on Pearl Harbor.
- Many know that D-Day awaited the right weather before it began. Many don't know that a freak storm destroyed floating docks shortly beforehand, almost canceling the invasion.
- During the 1991 Persian Gulf War, heavy winds prevented Saddam Hussein from launching Scud missiles at Israel and coalition forces.
- During the Persian Gulf War and the Iraq war, sandstorms delayed or stopped operations and did tremendous damage to equipment. In March 2003, the entire invasion of Iraq was stalled for three days because of a massive sandstorm.

These examples are not meant to suggest that weather changes will put the American military at a disadvantage. They do, however, help illustrate ways in which climate change can add new layers of complexity to military operations. An increase in extreme weather can make the most demanding of tasks even more challenging.



FINDINGS AND RECOMMENDATIONS

This report is intended to advance a more rigorous national and international dialogue on the impacts of climate change on national security. We undertook this analysis for the primary purpose of presenting the problem and identifying first-order solutions. We therefore keep this list of findings and recommendations intentionally brief. We hope it will stimulate further discussion by the public and a more in-depth analysis by those whose job it is to plan for our national security.

FINDINGS

Finding 1:
Projected climate change poses a serious threat to America's national security.

Potential threats to the nation's security require careful study and prudent planning—to counter and mitigate potential detrimental outcomes. Based on the evidence presented, the Military Advisory Board concluded that it is appropriate to focus on the serious consequences to our national security that are likely from unmitigated climate change. In already-weakened states, extreme weather events, drought, flooding, sea level rise, retreating glaciers, and the rapid spread of life-threatening diseases will themselves have likely effects: increased migrations, further weakened and failed states, expanded ungoverned spaces, exacerbated underlying conditions that terrorist groups seek to exploit, and increased internal conflicts. In developed countries, these conditions threaten to disrupt economic trade and introduce new security challenges, such as increased spread of infectious disease and increased immigration.

Overall, climate change has the potential to disrupt our way of life and force changes in how we keep ourselves safe and secure by adding a new hostile and stressing factor into the national and international security environment.

Finding 2:
Climate change acts as a threat multiplier for instability in some of the most volatile regions of the world.

Many governments in Asia, Africa, and the Middle East are already on edge in terms of their ability to provide basic needs: food, water, shelter and stability. Projected climate change will exacerbate the problems in these regions and add to the problems of effective governance. Unlike most conventional security threats that involve a single entity acting in specific ways at different points in time, climate change has the potential to result in multiple chronic conditions, occurring globally within the same time frame. Economic and environmental conditions in these already fragile areas will further erode as food production declines, diseases increase, clean water becomes increasingly scarce, and populations migrate in search of resources. Weakened and failing governments, with an already thin margin for survival, foster the conditions for internal conflict, extremism, and movement toward increased authoritarianism and radical ideologies. The U.S. may be drawn more frequently into these situations to help to provide relief, rescue, and logistics, or to stabilize conditions before conflicts arise.

Because climate change also has the potential to create natural and humanitarian disasters on a scale far beyond those we see today, its consequences will likely foster political instability where societal demands exceed the capacity of governments to cope. As a result, the U.S. may also be called upon to undertake stability and reconstruction efforts once a conflict has begun.

Finding 3:
Projected climate change will add to tensions even in stable regions of the world.

Developed nations, including the U.S. and Europe, may experience increases in immigrants and refugees as drought increases and food production declines in Africa and Latin America. Pandemic disease caused by the spread of infectious diseases and extreme weather events and natural disasters, as the U.S. experienced with Hurricane Katrina, may lead to increased domestic missions for U.S. military personnel—lowering troop availability for other missions and putting further stress on our already stretched military, including our Guard and Reserve forces.

Our current National Security Strategy, released in 2002 and updated in 2006, refers to globalization and other factors that have changed the security landscape. It cites, among other factors, "environmental destruction, whether caused by human behavior or cataclysmic mega-disasters such as floods, hurricanes, earthquakes or tsunamis. Problems of this scope may overwhelm the capacity of local authorities to respond, and may even overtax national militaries, requiring a larger international response. These challenges are not traditional national security concerns, such as the conflict of arms or ideologies. But if left unaddressed they can threaten national security."

In addition to acknowledging the national security implications of extreme weather and other environmental factors, the National Security Strategy indicates that the U.S. may have to intervene militarily, though it clearly states that dealing with the effects of these events should not be the role of the U.S. military alone.

Despite the language in our current National Security Strategy, there is insufficient planning and preparation on the operational level for future environmental impacts. However, such planning can readily be undertaken by the U.S. military in cooperation with the appropriate civilian agencies, including the State Department, the United States Agency for International Development, and the intelligence community.

Finding 4:
Climate change, national security, and energy dependence are a related set of global challenges.

As President Bush noted in his 2007 State of the Union speech, dependence on foreign oil leaves us more vulnerable to hostile regimes and terrorists, and clean domestic energy alternatives help us confront the serious challenge of global climate change. Because the issues are linked, solutions to one affect the others. Technologies that improve energy efficiency also reduce carbon intensity and carbon emissions.

RECOMMENDATIONS

Recommendation 1:
The national security consequences of climate change should be fully integrated into national security and national defense strategies.
As military leaders, we know we cannot wait for certainty. Failing to act because a warning isn't precise is unacceptable. Numerous parts of the U.S. government conduct analyses of various aspects of our national security situation covering different time frames and at varying levels of detail. These analyses should consider the consequences of climate change.

The intelligence community should incorporate climate consequences into its National Intelligence Estimate. The National Security Strategy should directly address the threat of climate change to our national security interests. It also should include an assessment of the national security risks of climate change and direct the U.S. government to take appropriate preventive efforts now.

The National Security Strategy and the National Defense Strategy should include appropriate guidance to military planners to assess risks to current and future missions of projected climate change, guidance for updating defense plans based on these assessments, and the capabilities needed to reduce future impacts. This guidance should include appropriate revisions to defense plans, including working with allies and partners, to incorporate climate mitigation strategies, capacity building, and relevant research and development.

The next Quadrennial Defense Review should examine the capabilities of the U.S. military to respond to the consequences of climate change, in particular, preparedness for natural disasters from extreme weather events, pandemic disease events, and other missions the U.S. military may be asked to support both at home and abroad. The capability of the National Guard and Reserve to support these missions in the U.S. deserve special attention, as they are already stretched by current military operations.

The U.S. should evaluate the capacity of the military and other institutions to respond to the consequences of climate change. All levels of government—federal, state, and local—will need to be involved in these efforts to provide capacity and resiliency to respond and adapt.

Scientific agencies such as the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA) and the United States Geologic Survey (USGS) should also be brought into the planning processes.
The defense and intelligence communities should conduct research on global climate and monitor global climate signals to understand their national security implications. Critical security-relevant knowledge about climate change has come from the partnership between environmental scientists and the defense and intelligence communities. That partnership, vibrant in the 1990s, should be revived.

Recommendation 2:
The U.S. should commit to a stronger national and international role to help stabilize climate changes at levels that will avoid significant disruption to global security and stability.
All agencies involved with climate science, treaty negotiations, energy research, economic policy, and national security should participate in an interagency process to develop a deliberate policy to reduce future risk to national security from climate change. Actions fall into two main categories: mitigating climate change to the extent possible by setting targets for long-term reductions in greenhouse gas emissions and adapting to those effects that cannot be mitigated. Since this is a global problem, it requires a global solution with multiple relevant instruments of government contributing.

While it is beyond the scope of this study to recommend specific solutions, the path to mitigating the worst security consequences of climate change involves reducing global greenhouse gas emissions. Achieving this outcome will also require cooperation and action by many agencies of government.

Recommendation 3:
The U.S. should commit to global partnerships that help less developed nations build the capacity and resiliency to better manage climate impacts.
Some of the nations predicted to be most affected by climate change are those with the least capacity to adapt or cope. This is especially true in Africa, which is becoming an increasingly important source of U.S. oil and gas imports. Already suffering tension and stress resulting from weak governance and thin margins of survival due to food and water shortages, Africa would be yet further challenged by climate change. The proposal by DoD to establish a new Africa Command reflects Africa's emerging strategic importance to the U.S., and with humanitarian catastrophes already occurring, a worsening of conditions could prompt further U.S. military engagement. As a result, the U.S. should focus on enhancing the capacity of weak African governments to better cope with societal needs and to resist the overtures of well-funded extremists to provide schools, hospitals, health care, and food.

The U.S. should target its engagement efforts, through regional military commanders and other U.S. officials, toward building capacity to mitigate destabilizing climate impacts. For example, regional commanders have routinely used such engagement tools as cooperation on disaster preparedness to help other nations develop their own ability to conduct these efforts.

Cooperative engagement has the potential to reduce the likelihood of war fighting. As Gen. Anthony C. (Tony) Zinni (Ret.) has said: "When I was commander of CENTCOM, I had two missions: engagement and war fighting: If I do engagement well, I won't have to do war fighting." The U.S. cannot do this alone; nor should the military be the sole provider of such cooperative efforts. But the U.S. can lead by working in cooperation with other nations. Such efforts promote greater regional cooperation, confidence building and the capacity of all elements of national influence to contribute to making nations resilient to the impacts of climate change.

Recommendation 4:
The Department of Defense 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.
DoD should require more efficient combat systems and should include the actual cost of delivering fuel when evaluating the advantages of investments in efficiency. Numerous DoD studies dating from the 2001 Defense Science Board report "More Capable Warfighting Through Reduced Fuel Burden" have concluded that high fuel demand by combat forces detracts from our combat capability, makes our forces more vulnerable, diverts combat assets from offense to supply line protection, and increases operating costs. Nowhere are these problems more evident than

in Iraq, where every day 2.4 million gallons of fuel is moved through dangerous territory, requiring protection by armored combat vehicles and attack helicopters.

Deploying technologies that make our forces more efficient also reduces greenhouse gas emissions. DoD should invest in technologies that will provide combat power more efficiently. The resulting technologies would make a significant contribution to the vision President Bush expressed in his State of the Union when he said, "America is on the verge of technological breakthroughs that … will help us to confront the serious challenge of global climate change."

Recommendation 5:
DoD should conduct an assessment of the impact on U.S. military installations worldwide of rising sea levels, extreme weather events, and other possible climate change impacts over the next 30 to 40 years.

As part of prudent planning, DoD should assess the impact of rising sea levels, extreme weather events, droughts, and other climate impacts on its infrastructure so its installations and facilities can be made more resilient.

Numerous military bases, both in the U.S. and overseas, will be affected by rising sea levels and increased storm intensity. Since World War II, the number of overseas bases has diminished, and since the Base Realignment and Closure process began the number of stateside bases has also declined. This makes those that remain more critical for training and readiness, and many of them are susceptible to the effects of climate change. For example, the British Indian Ocean Territory island of Diego Garcia, an atoll in the southern Indian Ocean, is a major logistics hub for U.S. and British forces in the Middle East. It is also only a few feet above sea level at its highest point. The consequences of the losing places like Diego Garcia are not insurmountable, but are significant and would require advance military planning. The Kwajalein is a low-lying atoll, critical for space operations and missile tests. Guam is the U.S. gateway to Asia and could be moderately or severely affected by rising sea levels. Loss of some forward bases would require us to have longer range lift and strike capabilities and possibly increase our military's energy needs.

Military bases on the eastern coast of the U.S. are vulnerable to hurricanes and other extreme weather events. In 1992, Hurricane Andrew virtually destroyed Homestead Air Force Base in Florida. In 2004 Hurricane Ivan knocked out Naval Air Station Pensacola for almost a year. Most U.S. Navy and Coast Guard bases are located on the coast, as are most U.S. Marine Corps locations. The Army and Air Force also operate bases in low-lying or coastal areas. One meter of sea level rise would inundate much of Norfolk, Virginia, the major East Coast hub for the U.S. Navy. As key installations are degraded, so is the readiness of our forces.

APPENDICES

APPENDIX 1:
BIOGRAPHIES, MILITARY ADVISORY BOARD MEMBERS

ADMIRAL FRANK "SKIP" BOWMAN, USN (Ret.)

Former Director, Naval Nuclear Propulsion Program;
Former Deputy Administrator-Naval Reactors, National Nuclear Security Administration

Admiral Skip Bowman was director, Naval Nuclear Propulsion, Naval Sea Systems Command. Prior assignments include deputy administrator for naval reactors in the Naval Nuclear Security Administration, Department of Energy; chief of naval personnel; and director for Political-Military Affairs and deputy director of naval operations on the Joint Staff.

He was commissioned following graduation in 1966 from Duke University. In 1973, he completed a dual master's program in nuclear engineering and naval architecture/marine engineering at the Massachusetts Institute of Technology and was elected to the Society of Sigma Xi. Admiral Bowman has been awarded the honorary degree of Doctor of Humane Letters from Duke University.

In 2005, Admiral Bowman was named president and CEO of the Nuclear Energy Institute. NEI is the policy organization for the commercial nuclear power industry. In 2006, Admiral Bowman was made an Honorary Knight Commander of the Most Excellent Order of the British Empire in recognition of his commitment in support of the Royal Navy submarines program.

LIEUTENANT GENERAL LAWRENCE P. FARRELL JR., USAF (Ret.)

Former Deputy Chief of Staff for Plans and Programs, Headquarters U.S. Air Force

Prior to his retirement from the Air Force in 1998, General Farrell served as the deputy chief of staff for plans and programs, Headquarters U.S. Air Force, Washington, D.C. He was responsible for planning, programming and manpower activities within the corporate Air Force and for integrating the Air Force's future plans and requirements to support national security objectives and military strategy.

Previous positions include vice commander, Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio, and deputy director, Defense Logistics Agency, Arlington, Virginia. He also served as deputy chief of staff for plans and programs at Headquarters U.S. Air Force in Europe. A command pilot with more than 3,000 flying hours, he flew 196 missions in Southeast Asia and commanded the 401st Tactical Fighter Wing, Torrejon Air Base, Spain. He was also the system program manager for the F-4 and F-16 weapons systems with the Air Force Logistics Command, Hill Air Force Base, Utah.

General Farrell is a graduate of the Air Force Academy with a bachelor's degree in engineering and an MBA from Auburn University. Other education includes the National War College and the Harvard Program for Executives in National Security.

General Farrell became the president and CEO of the National Defense Industrial Association in September 2001.

VICE ADMIRAL PAUL G. GAFFNEY II, USN (Ret.)

Former President, National Defense University; Former Chief of Naval Research and Commander, Navy Meteorology and Oceanography Command

Admiral Gaffney has been the Naval Research Laboratory commander and worked in a number of other science and oceanography administration assignments. He served as the 10th president of the National Defense University, and before that as chief of naval research. He also was the senior uniformed oceanography specialist in the Navy, having served as commander of the Navy Meteorology and Oceanography Command from 1994 to 1997. He was appointed by President George W. Bush to the Ocean Policy Commission and served during its full tenure from 2001 to 2004. He served in Japan, Vietnam, Spain, and Indonesia, and traveled extensively in official capacities.

He has been recognized with a number of military decorations; the Naval War College's J. William Middendorf Prize for Strategic Research, the Outstanding Public Service Award from the Virginia Research and Technology Consortium, and the Potomac Institute's Navigator Award. He has served on several boards of higher education and was a member of the Ocean Studies Board of the National Re-search Council from 2003 to 2005. He has been selected to be a public trustee for the New Jersey Consortium and chaired the Governor's Commission to Protect and Enhance New Jersey's Military Bases.

He graduated from the U.S. Naval Academy in 1968 and has a master's degree in mechanical engineering (ocean) from Catholic University and a master's of business administration from Jacksonville University.

Admiral Gaffney is currently the president of Monmouth University in West Long Branch, New Jersey.

GENERAL PAUL J. KERN, USA (Ret.)

Former Commanding General, U.S. Army Materiel Command

General Kern was commanding general, Army Materiel Command from 2001 to 2004, and senior adviser for Army Research, Development, and Acquisition from 1997 to 2001.

General Kern had three combat tours. Two were in Vietnam as a platoon leader and troop commander. His third was as commander of the Second Brigade of the 24th Infantry in Desert Shield/Desert Storm. The Second Brigade played a pivotal role in the historic attack on the Jalibah Airfield, which allowed the Twenty-Fourth Infantry Division to secure key objectives deep inside of Iraq. He also served as the assistant division commander of the division after its redeployment to Fort Stewart, Georgia.

General Kern's assignments included senior military assistant to Secretary of Defense William Perry. During that period, he accompanied Secretary Perry to more than 70 countries, meeting numerous heads of state, foreign ministers, and international defense leaders. He participated in U.S. operations in Haiti, Rwanda, Zaire, and the Balkans, and helped promote military relations in Central and Eastern Europe, South America, China, and the Middle East.

General Kern received the Defense and Army Distinguished Service Medals, Silver Star, Defense Superior Service Medal, Legion of Merit, two Bronze Star Medals for valor, three Bronze Star Medals for service in combat, and three Purple Hearts. He has been awarded the Society of Automotive Engineers Tester Award, the Alumni Society Medal from the University of Michigan, and the German Cross of Honor of the Federal Armed Forces (Gold).

A native of West Orange, New Jersey, General Kern was commissioned as an armor lieutenant following graduation from West Point in 1967. He holds master's degrees in both civil and mechanical engineering from the University of Michigan, and he was a Senior Security Fellow at the John F. Kennedy School of Government at Harvard University.

He is an adviser to Battelle Memorial Institute and holds the Chair of the Class of 1960 for Advanced Technology at the United States Military Academy.

General Kern is a member of the Cohen Group, which provides strategic advice and guidance to corporate clients.

ADMIRAL T. JOSEPH LOPEZ, USN (Ret.)

Former Commander-in-Chief, U.S. Naval Forces Europe and of Allied Forces, Southern Europe

Admiral Lopez's naval career included tours as commander-in-chief of U.S. Naval Forces Europe and commander-in-chief, Allied Forces, Southern Europe from 1996 to 1998. He commanded all U.S. and Allied Bosnia Peace Keeping Forces in 1996; he served as deputy chief of naval operations for resources, warfare requirements and assessments in 1994 to 1996.; commander of the U.S. Sixth Fleet in 1992 to 1993; and senior military assistant to the secretary of defense in 1990 to 1992.

Admiral Lopez was awarded numerous medals and honors, including two Defense Distinguished Service Medals, two Navy Distinguished Service Medals, three Legion of Merits, the Bronze Star (Combat V), three Navy Commendation Medals (Combat V) and the Combat Action Ribbon. He is one of just two flag officers in the history of the U.S. Navy to achieve four-star rank after direct commission from enlisted service.

He holds a bachelor's degree (cum laude) in international relations and a master's degree in management. He has been awarded an honorary doctorate degree in humanities from West Virginia Institute of Technology and an honorary degree in information technology from Potomac State College of West Virginia University.

Admiral Lopez is president of Information Manufacturing Corporation (IMC), an information technology service integrator with major offices in Manassas, Virginia, and Rocket Center, West Virginia.

ADMIRAL DONALD L. "DON" PILLING, USN (Ret.)

Former Vice Chief of Naval Operations

Admiral Pilling assumed duties as the 30th vice chief of naval operations, the Navy's chief operating officer and second-ranking officer, from November 1997 until his retirement from active service in October 2000.

Ashore, he was assigned to a variety of defense resources and planning billets. In his earlier career, he served four years in program analysis and evaluation in the Office of the Secretary of Defense. As a more senior officer, he served as a Federal Executive Fellow at the Brookings Institution in 1985-86. A member of the National Security Council staff from 1989 until 1992, Admiral Pilling was selected to flag rank in 1989 while serving there. From 1993 to 1995, he was the director for programming on the staff of the Chief of Naval Operations, and later served as the Navy's chief financial officer from 1996 to 1997.

Admiral Pilling also commanded a warship; a destroyer squadron; a cruiser destroyer group; a carrier battle group; the U.S. Sixth Fleet; and NATO's Naval Striking and Support Forces Southern Europe.

Admiral Pilling has a bachelor's degree in engineering from the U.S. Naval Academy and a doctorate in mathematics from the University of Cambridge.

He served as vice president for strategic planning at Battelle Memorial Institute and became president and CEO of LMI, a nonprofit research organization, in 2002.

ADMIRAL JOSEPH W. PRUEHER, USN (Ret.)

Former Commander-in-Chief of the U.S. Pacific Command (PACOM) and Former U.S. Ambassador to China

Admiral Prueher completed thirty-five years in the United States Navy in 1999. His last command was commander-in-chief of the U.S. Pacific Command (CINCPAC); the largest military command in the world, spanning over half the earth's surface and including more than 300,000 people. Admiral Prueher also served as ambassador to China from 1999 to 2001. He served two presidents and was responsible for directing, coordinating, and managing the activities of all United States executive branch activities in China.

From 1989 through 1995, Admiral Prueher served as commandant at the U.S. Naval Academy at Annapolis; commander of Carrier Battle Group ONE based in San Diego; commander of the U.S. Mediterranean Sixth Fleet and of NATO Striking Forces based in Italy; and as vice chief of naval operations in the Pentagon.

Admiral Prueher graduated from Montgomery Bell Academy in Nashville, Tennessee, and then graduated with distinction in 1964 from the U.S. Naval Academy, later receiving a master's degree in international relations from George Washington University. He is also a graduate of the Naval War College in Newport, Rhode Island. In addition to co-authoring the Performance Testing manual used by naval test pilots for many years, he has published numerous articles on leadership, military readiness, and Pacific region security issues. Admiral Prueher has received multiple military awards for combat flying as well as naval and Joint Service. The governments of Singapore, Thailand, Japan, Korea, the Philippines, Indonesia, and Australia have decorated him.

Admiral Prueher is a consulting professor at Stanford University's Institute of International Studies and senior adviser on the Preventive Defense Project. He is on the board of trustees of the Nature Conservancy of Virginia.

GENERAL GORDON R. SULLIVAN, USA (Ret.)

Chairman, Military Advisory Board

Former Chief of Staff, U.S. Army

General Sullivan was the 32nd chief of staff—the senior general officer in the Army and a member of the Joint Chiefs of Staff. As the chief of staff of the Army, he created the vision and led the team that helped transition the Army from its Cold War posture.

His professional military education includes the U.S. Army Armor School Basic and Advanced Courses, the Command and General Staff College, and the Army War College. During his Army career, General Sullivan also served as vice chief of staff in 1990 to 1991; deputy chief of staff for operations and plans in 1989 to 1990; commanding general, First Infantry Division (Mechanized), Fort Riley, Kansas, in 1988 to 1989; deputy commandant, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas, in 1987 to 1988; and assistant commandant, U.S. Army Armor School, Fort Knox, Kentucky, from 1983 to 1985. His overseas assignments included four tours in Europe, two in Vietnam and one in Korea. He served as chief of staff to Secretary of Defense Dick Cheney in the administration of President George H.W. Bush.

General Sullivan was commissioned a second lieutenant of armor and awarded a bachelor of arts degree in history from Norwich University in 1959. He holds a master's degree in political science from the University of New Hampshire.

General Sullivan is the president and chief operating officer of the Association of the United States Army, headquartered in Arlington, Virginia. He assumed his current position in 1998 after serving as president of Coleman Federal in Washington, D.C.

VICE ADMIRAL RICHARD H. TRULY, USN (Ret.)

Former NASA Administrator, Shuttle Astronaut and the first Commander of the Naval Space Command

Admiral Truly served as NASA's eighth administrator from 1989 to 1992, and his career in aviation and space programs of the U.S. Navy and NASA spanned 35 years. He retired as a vice admiral after a Navy career of more than thirty years. As a naval aviator, test pilot and astronaut, he logged over 7,500 hours and made over 300 carrier-arrested landings, day and night.

Admiral Truly was the first commander of Naval Space Command from 1983 to 1986 and became the first naval component commander of U.S. Space Command upon its formation in 1984. While still on active duty following the *Challenger* accident, he was called back to NASA as associate administrator for space flight in 1986 and led the accident investigation. He spearheaded the painstaking rebuilding of the space shuttle, including winning approval of President Reagan and the Congress for building of *Endeavor* to replace the lost *Challenger*. In 1989, President Reagan awarded him the Presidential Citizen's Medal.

Truly's astronaut career included work in the Air Force's Manned Orbiting Laboratory program, and NASA's Apollo, Skylab, Apollo-Soyuz and space shuttle programs. He piloted the *747/Enterprise* approach and landing tests in 1977, and lifted off in November 1981 as pilot aboard *Columbia*, the first shuttle to be reflown into space, establishing a world circular orbit altitude record. He commanded *Challenger* in August-September 1983, the first night launch/landing mission of the space shuttle program.

He served as vice president of the Georgia Institute of Technology and director of the Georgia Tech Research Institute (GTRI) from 1992 to 1997. Admiral Truly retired in January 2005 as director of the Department of Energy's National Renewable Energy Laboratory (NREL).

Truly is a member of the National Academy of Engineering. He has previously served on the board of visitors to the U.S. Naval Academy, the Defense Policy Board, the Army Science Board, and the Naval Studies Board. He is a member of the National Research Council Space Studies Board, a trustee of Regis University and the University Corporation for Atmospheric Research, and a member of the advisory committee to the Colorado School of Mines Board of Trustees.

GENERAL CHARLES F. "CHUCK" WALD, USAF (Ret.)

Former Deputy Commander, Headquarters U.S. European Command (USEUCOM)

From 2001 to 2002 General Wald was deputy chief of staff for air and space operations at the Pentagon, and from December 2002 until his retirement in 2006 General Wald was deputy commander, Headquarters U.S. European Command, Stuttgart, Germany. USEUCOM is responsible for all U.S. forces operating across 91 countries in Europe, Africa, Russia, parts of Asia and the Middle East, and most of the Atlantic Ocean.

General Wald commanded the 31st Fighter Wing at Aviano Air Base, Italy, where on Aug. 30, 1995, he led one of the wing's initial strike packages against the ammunition depot at Pale, Bosnia-Herzegovina, in one of the first NATO combat operations. General Wald commanded the Ninth Air Force and U.S. Central Command Air Forces, Shaw Air Force Base, South Carolina, where he led the development of the Afghanistan air campaign for Operation Enduring Freedom, including the idea of embedding tactical air control parties in ground special operations forces. He has combat time as an O-2A forward air controller in Vietnam and as an F-16 pilot flying over Bosnia. The general has served as a T-37 instructor pilot and F-15 flight commander. Other duties include chief of the U.S. Air Force Combat Terrorism Center, support group commander, operations group commander, and special assistant to the chief of staff for National Defense Review. He was also the director of strategic planning and policy at Headquarters U.S. Air Force, and served on the Joint Staff as the vice director for strategic plans and policy.

General Wald is a command pilot with more than 3,600 flying hours, including more than 430 combat hours over Vietnam, Cambodia, Laos, Iraq, and Bosnia. The general earned his commission through the Air Force ROTC program in 1971.

Currently, General Wald serves as president of Wald and Associates, an international management consulting and strategic planning firm, and is an adjunct lecturer at the Atlantic Council. He is also a member of the Bipartisan Policy Center, National Commission on Energy Policy, and the Securing America's Future Energy Commission.

GENERAL ANTHONY C. "TONY" ZINNI, USMC (Ret.)

Former Commander-in-Chief of U.S. Central Command (CENTCOM)

General Zinni's joint assignments included command of U.S. Central Command (CENTCOM), which is responsible for U.S. military assets and operations in the Middle East, Central Asia and East Africa.

General Zinni's joint assignments also include command of a joint task force and he has also had several joint and combined staff billets at task force and unified command levels. He has made deployments to the Mediterranean, the Caribbean, the Western Pacific, Northern Europe, and Korea. He has held numerous command and staff assignments that include platoon, company, battalion, regimental, Marine Expeditionary Unit, and Marine expeditionary force command. His staff assignments included service in operations, training, special operations, counter-terrorism and manpower billets. He has also been a tactics and operations instructor at several Marine Corps schools and was selected as a fellow on the Chief of Naval Operations Strategic Studies Group.

General Zinni joined the Marine Corps in 1961 and was commissioned an infantry second lieutenant in 1965. General Zinni holds a bachelor's degree in economics from Villanova University, a master's in international relations from Salves Regina College, a master's in management and supervision from Central Michigan University, and honorary doctorates from William and Mary College and the Maine Maritime Academy.

He has worked with the University of California's Institute on Global Conflict and Cooperation, the U.S. Institute of Peace, and the Henry Dunant Centre for Humanitarian Dialogue in Geneva. He is on the International Council at the Joan B. Kroc Institute for Peace and Justice. He is also a Distinguished Advisor at the Center for Strategic and International Studies, a member of the Council on Foreign Relations. He has also been appointed as a member of the Virginia Commission on Military Bases.

General Zinni has co-authored, with Tom Clancy, a New York Times bestseller on his career entitled *Battle Ready*. His book, *The Battle For Peace: A Frontline Vision Of America's Power And Purpose*, was published in 2006.

APPENDIX 2:
CLIMATE CHANGE SCIENCE—A BRIEF OVERVIEW

There is a vast amount of scientific literature on the subject of climate change, and a complete discussion on the current state of the world climate and its deviation from climatological norms could fill volumes. In this appendix we discuss the consensus of the science community on climate change, effects observed thus far, and projections about what may happen in the future.

We have drawn information from the Intergovernmental Panel on Climate Change (IPCC), peer-reviewed scientific literature, and data, reports, and briefings from various respected sources, including the National Academy of Sciences, National Oceanic and Atmospheric Administration, National Air and Space Administration, and the United Kingdom's Hadley Centre for Climate Change.

CURRENT CONSENSUS

The IPCC's latest assessment report affirmed the following:

- While natural forces have influenced the earth's climate (and always will), human-induced changes in levels of atmospheric greenhouse gases are playing an increasingly dominant role.
- After considering the influences of the known causes of climate change—natural- and human-induced—the significant increase in the average global temperatures over the last half century can be attributed to human activities with a certainty of more than 90 percent [7].
- Those temperature increases have already affected various natural systems in many global regions.
- Future changes to the climate are inevitable.

CHANGING GLOBAL TEMPERATURES

INCREASED CARBON MEANS INCREASED TEMPERATURES

Throughout its history, the earth has experienced oscillations between warm and cool periods. These shifts in climate have been attributed to a variety of factors, known as "climate forcings," that include orbital variations, solar fluctuations, landmass distribution, volcanic activity, and the atmosphere's concentration of greenhouse gases, such as carbon dioxide, methane, and water vapor. The changes we see today are occurring at a more rapid rate than is explainable by known natural cycles [15].

Throughout the earth's past, temperature and greenhouse gas concentration have been closely linked through the planet's natural greenhouse effect; i.e. greenhouse gases trap heat in the atmosphere and thereby warm the earth. Throughout Earth's previous four glacial and warming cycles, atmospheric CO_2 concentration, and temperature show a high degree of correlation. Other greenhouse gases, such as methane, also show a similar relationship with temperature.

The recent and rapid rise in atmospheric CO_2 levels is of concern to climate scientists and policymakers. CO_2 concentrations never exceeded 300 parts per million by volume (ppmv) during previous large swings in climate conditions, but the CO_2 concentration now is about 380 ppmv [41], representing a 35 percent increase since the onset of the industrial revolution in the mid-eighteenth century. CO_2 levels are likely at their highest levels in the last 20 million years, and "the current rate of increase is unprecedented during at least the last 20,000 years" [41].

Thus, the current atmosphere is significantly different from its preindustrial state in a way that is compatible with increased heating.

AVERAGE GLOBAL TEMPERATURES HAVE ALREADY BEGUN TO RISE

Average global surface temperature is the most fundamental measure of climate change, and there is no dispute that the earth's average temperature has been increasing over the last century (albeit not uniformly), with an acceleration in warming over the last 50 years. Over the last century, the average surface temperature around the world has increased by 1.3°F ± 0.3°F [7]. Temperatures since the 1950s were "likely the highest [of any 50-year period] in at least the past 1,300 years" [7]. Of the hottest twelve years on record since temperatures began to be measured in the 1850s, eleven have occurred in the last twelve years [7].

The burning of fossil fuels (such as oil, natural gas, and coal) is the main source of the rise in atmospheric CO_2 over the last two and a half centuries; deforestation and other changes in land use are responsible for a portion of the increase as well.

Human activities have also been responsible for a portion of the rise in other heat-trapping greenhouse gases, such as methane, which has risen 148 percent since preindustrial times, and nitrous oxide, which has risen 18 percent during the same period. Currently, half of the annual methane emitted is from activities such as burning fossil fuel and agricultural processes; [41] humans are responsible for about a third of nitrous oxide emissions, mainly from agriculture.

There is no known natural forcing that can account for the severity of the recent warming. For example, while claims are made that variation in the intensity of the sun is responsible, the variation in solar radiation's effect on the climate is estimated to be less than 5 percent as strong as that of human-induced greenhouse gases [7].

MORE THAN TEMPERATURE RISE: OBSERVED IMPACTS ON EARTH'S NATURAL SYSTEMS

A 1.3°F increase in average global surface temperature over the last century may seem like an insignificant change, but in fact it has had a marked impact on many of the earth's natural systems.

PRECIPITATION PATTERNS HAVE CHANGED

A change in the temperature of the atmosphere has a great impact on pre-cipitation patterns. As an air mass warms, it is able to hold more water vapor, so a warmer atmosphere can absorb more surface moisture and produce drier ground conditions. However, this increase in atmospheric content will also lead to more severe heavy rain events, when this higher water-content atmosphere drops its moisture.

Changes in precipitation amounts have been detected over large portions of the world. Annual precipitation has increased 5 to 10 percent over the past century across eastern North America, northern Europe, and northern and central Asia [7, 41]. The Mediterranean region experienced drying [7]. The tropics have witnessed a slightly lower increase, of 2 to 3 percent, and most of sub-Saharan Africa has shown a decrease in precipitation of 30 to 50 percent [42].

The Northern Hemisphere subtropics experienced a decrease in precipitation of approximately 2 percent [41]. Some of the most noticeable drying occurred in the Sahel and portions of southern Asia [7]. No significant change was detected in rainfall patterns across wide areas in the Southern Hemisphere; however, precipitation was noticeably decreased in southern Africa [41].

EXTREME WEATHER EVENTS ARE MORE FREQUENT

Since 1950, cold days and nights and frost days have become less frequent, while hot days and nights and heat waves have become more frequent [7].

Global patterns of both heavy precipitation events and intense droughts have changed over recent decades. The increase in heavy precipitation events is consistent with the general increase in temperatures and the commensurate increase in atmospheric water vapor content. Droughts have become more intense, particularly in the tropics and subtropics, because of higher temperatures, more frequent heat waves, and changes in precipitation patterns [7].

The combination of increasing atmospheric temperatures and increased sea surface temperatures can increase the energy of tropical storms [43]. Preliminary observations since 1970 suggest that this effect has been observed in the North Atlantic and perhaps other regions as well [7].

ICE AND SNOW COVER IS DISAPPEARING

Glacial ice and snow cover are disappearing in many regions around the world. The Arctic region, in particular, is one of the areas being affected most by rising temperatures. As a result of temperatures that have increased at nearly twice the global average rate, Arctic sea ice is thinning and shrinking in extent, glaciers are melting throughout the region, and the snow season has shortened. Alaskan glaciers have retreated at a rapid pace; in fact, the amount of glacial mass lost in Alaska alone represents half of the estimated worldwide total [44]. There will be little to no sea ice in the Arctic's summers toward the end of this century [7]. Glaciers in other regions, such as high-altitude glaciers in tropical areas, are also melting at an increasing rate [7].

Increased melting of the Greenland ice sheet is one of the most worrisome Earth responses observed thus far. Data from NASA's Goddard Space Flight Center show that the seasonal melt area over Greenland has trended upward at 7 percent per year over the last twenty-five years, and the ice shelf surrounding Greenland has thinned by 230 feet over the last five years [15]. Recent satellite data analyzed by NASA have shown that from 2003 through 2005, Greenland annually lost three times more ice through melting than it gained through snowfall [45].

Antarctica's ice cover has also responded to the increasing temperature, but in different ways. West Antarctica has lost ice mass, while the ice sheet in East Antarctica has thickened. The thickening has been explained as being due to increased snow fall (as a result of warming temperatures that lead to more water vapor in the atmosphere) [46] as well as a slowing of glaciers for reasons unrelated to climate [45].

The melting of ice cover is an important positive feedback that reinforces heating, because of ice's contribution to the reflectivity of the earth. As ice melts, it exposes either land or water, depending on its location. Because land and water both reflect less solar radiation than ice, they reinforce rising temperatures, which in turn melts more ice. Once such loops begin, predicting their stopping point is difficult.

OCEANS ARE WARMING

The oceans have an enormous capacity to hold heat; because of their volume and heat capacity they require extremely large inputs of heat to change their temperatures. Nevertheless, the global mean sea surface temperature increased 0.9°F globally in the twentieth century [47], and the IPCC stated that "global ocean heat content has increased significantly since the late 1950s" [41].

SEA LEVELS ARE RISING

Ocean temperature is important to sea level rise because as temperatures increase, water expands, causing sea levels to rise. Because of the thermal inertia of the oceans, once sea level begins to rise because of thermal ex-pansion, it will continue to do so for centuries regardless of any mitigative actions.

Sea levels are also raised by the melting of land-based ice and snow because of the direct transfer of water into the sea. Sea-based ice, however, does not raise sea levels as it melts.

From 1961 through 2003, global mean sea level has risen about three inches, with nearly half of that increase occurring between 1993 and 2003 [7]. Over the entirety of the twentieth century, sea levels have risen nearly seven inches. The IPCC concluded that this rise was caused by thermal expansion of the ocean as well as melting of mountain glaciers and snow cover [7].

OCEAN SALINITY HAS CHANGED

Oceanographers have observed dramatic changes in salinity levels in the oceans. Oceans in the mid- and high latitudes have shown evidence of freshening, while those in tropical regions have increased in salinity [7].

Increases in ocean acidity have also been observed since preindustrial times. Increased atmospheric CO_2 is absorbed in the ocean where it combines with water to form carbonic acid, a mild acid. Most people are familiar with acid rain; this is its ocean equivalent. Forecasts project the increase in acidity over the coming century to be three times as great as the increase over the last 250 years [7]. Higher acidity could have a major impact on ocean life by preventing the formation of shells and skeletons of some very numerous and important zooplankton [48]. Coral reefs are particularly vulnerable.

FUTURE SCENARIOS: A CHOICE FOR HUMANS

To help illustrate the changes in climate that may occur, the IPCC developed a set of more than three dozen scenarios that describe different paths along which the world may evolve over the next century [49]. Those paths are divided into six overarching categories distinguished by the assumptions made for factors such as economic growth, interactions among nations, population growth, and technological advances.

The scenarios were used as inputs to drive various climate models. The IPCC's 2007 report documents a range of climate change outcomes for the next century for each of the six categories used. According to the IPCC report, when considering the climate model results for each scenario, the average temperature projected in years 2090 to 2099 is expected to exceed the average temperature observed from 1980 to 1999 by 2.0° to 11.5°F. Sea levels are projected to rise between seven and twenty-three inches. This projection does not include the effect of potential changes in ice flow dynamics of large, land-based glaciers that may further contribute to the rise in sea level. To put this in perspective, recall that over the last century, the temperature increased about 1.3°F, and the sea level increased seven inches.

Because most of the inter-model studies assessed by the IPCC focus on three specific scenario categories, the IPCC's 2007 report necessarily focuses mostly on the same three. The "low" scenario (i.e., the one that results in the lowest temperature increase) describes a future in which population levels come under control, the global economy moves away from a manufacturing focus, and nations work together on improvements in environmental sustainability and developing clean technologies. The "medium" scenario describes a future where the assumptions regarding population and economic growth are similar to those made in the low scenario. Moreover, in the "medium" scenario the IPCC assumes the development of efficient technologies, and the production of energy from a variety of sources other than fossil fuels. The "high" scenario is the same as the "middle" scenario except energy production remains heavily focused on fossil fuel sources.

Each of the IPCC scenarios lead to different projections for temperature change; however, they all project significant global warming, with the most intense warming occurring in the Arctic and the high northern latitudes.

Some of the areas hardest hit by temperature increases will also very likely experience significantly less rainfall by the end of the century. Domestically, the southwestern portion of the United States will very likely experience the worst combination of these factors. Decreasing precipitation and markedly increasing temperatures will also stress northern and southern Africa and the Middle East.

While the earth's natural systems will continue to experience greater stress due to future climate changes, so will some key human systems [24]:

- **Coastal populations:** Increases in flooding and inundation from rising seas and more intense storms will affect coastal populations across the world, particularly those in Bangladesh and low-lying island nations.
- **Agriculture:** Temperature increases of a few degrees and increases in atmospheric CO_2 levels

may help agricultural productivity in mid- and high latitudes but will surely hurt agriculture in the tropics and subtropics, where crops already exist at the top of their temperature range; higher increases in temperature, as well as heat waves, changes in precipitation, and increased pests, will hurt agricultural productivity across much of the globe.

• **Water resources:** Five billion people are expected to live in water-stressed countries by 2025 even without factoring in climate change. Expected changes in climate will exacerbate water-stress in some areas (including most of Asia, southern Africa, and the Mediterranean), while alleviating it in others (such as the United Kingdom). Areas that depend on tropical mountain glaciers for water (such as Lima, Peru), will face a precarious situation as the glaciers continue to melt and eventually disappear. Developing nations with little capacity to manage water will be among the hardest hit.

• **Health:** Rising temperatures and heat waves will increase the number of heat-related deaths in summer months. This increase will be partially offset by decreases in cold-related winter deaths. The reach of vector-borne diseases, such as malaria and dengue fever, is expected to spread. Increasing frequency of floods will harm human health by its direct impact on populations as well as by facilitating the spread of disease to affected areas. Vital health infrastructure can be damaged, making minor and treatable injuries become life-threatening.

A WILD CARD: ABRUPT CLIMATE CHANGE

For many years it was believed that climate changes have been gradual—that the earth gradually cycles between glacial periods and warm interglacial periods. We now know this is not always the case [50].

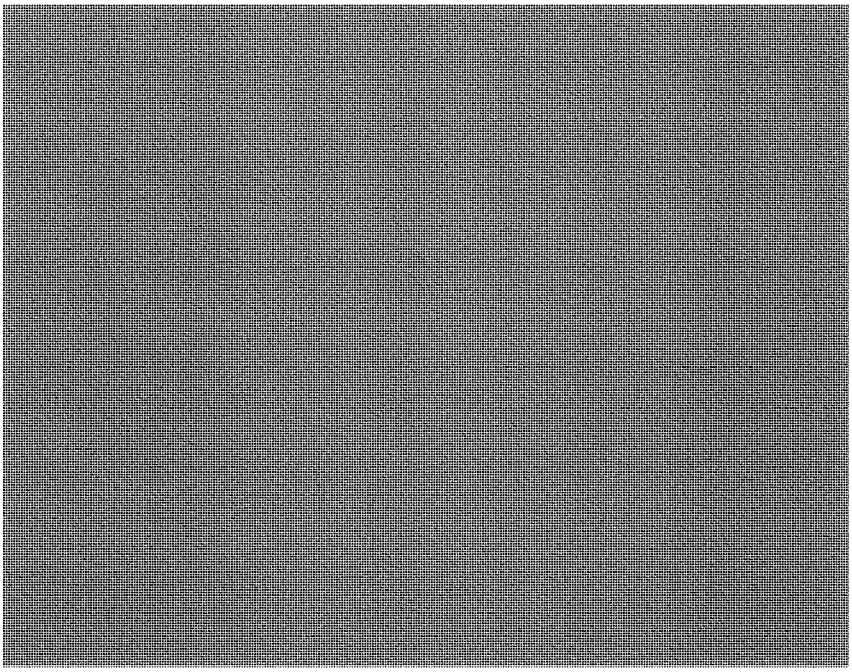
Abrupt climate changes present the most worrisome scenario for human societies because of the inherent difficulties in adapting to sudden changes. Abrupt sea level rise is particularly worrisome. The great ice sheets along the edges of Greenland and the West Antarctic are vulnerable to sudden breakup: as the edges of the sheet thaw and meltwater seeps to the ice-ground boundary, the meltwater will act as a lubricant and facilitate a slippage into the sea. This physical phenomenon is an example of a positive feedback mechanism that, once started, is difficult to reverse [15]. Melting of these ice sheets would be catastrophic. The Greenland Ice Sheet could raise sea levels by twenty-three feet over a millennium [7]; the West Antarctic Ice Sheet would have a more immediate impact, raising sea levels more than three feet per century for five centuries [41]. The probability of a collapse of the West Antarctic Ice Sheet before 2100 is estimated to be between 5 and 10 percent [7].

None of these abrupt climate changes are projected by the climate models driven by the IPCC's 2007 future scenarios. However, if temperature increases were at the high end of the ranges projected by the models, abrupt climate changes such as those discussed above are more likely to occur. Such abrupt climate changes could make future adaptation extremely difficult, even for the most developed countries.

REFERENCES

REFERENCES

1. Diamond, Jared. 2004. *Collapse: How Societies Choose to Fail or Succeed.* New York: Viking Adult.
2. Zinni, General Tony and Tony Koltz. 2006. *The Battle for Peace: A Frontline Vision of America's Power and Purpose.* New York: Palgrave Macmillan.
3. Janetos, Anthony. *Climate Change Impacts.* Briefing to the Military Advisory Board, September 8, 2006
4. Robert Marquand, "*Glaciers in the Himalayas Melting at Rapid Rate,*" Christian Science Monitor, November 5, 1999, as reported in Lester R. Brown's Eco-Economy: Building an Economy for the Earth. 2001. New York: W.W. Norton & Co.
5. International Water Management Institute. *Projected Water Scarcity in 2025.* http://www.iwmi.cgiar.org/home/wsmap.htm
6. Brown, Lester R. 2006. *World Grain Stocks Fall to 57 Days of Consumption.* Earth Policy Institute, June. http://www.earth-policy.org/Indicators/Grain/2006.htm
7. Intergovernmental Panel on Climate Change. *Fourth Assessment Report*, 2007
8. World Health Organization. *Global Climate Change and Health: An Old Story Writ Large.* 2003, ISBN 9241590815. http://www.who.int/globalchange /climate/summary/en/
9. Shope, R. E. 1992. *Impacts of Global Climate Change on Human Health: Spread of Infectious Disease.* Chapter 25 of Global Climate Change: Implications, Challenges and Mitigation Measures, ed. S. K. Majumdar, L. S. Kalkstein, B. Yarnal, E. W. Miller, and L. M. Rosenfeld, 363-70. Easton, PA: The Pennsylvania Academy of Science.
10. Hinrichsen, D. 1995. *Coasts in Crisis: Coasts and the Population Bomb.* American Association for the Advancement of Science, September 1995 http://www.aaas.org/international/ehr/fisheries/hinrichs.htm
11. Gleick, P. and E. Maurer. 1990. *Assessing the Costs of Adapting to Sea Level Rise: A Case Study of San Francisco Bay.* April 18, 1990. Pacific Institute for Studies in Development, Environment, and Security.
12. Hanson, Stephanie. 2006. *Brazil's Powerful Prison Gang.* Council on Foreign Relations, September 26, 2006. http://www.cfr.org/publication/11542/brazils _powerful_prison_gang.html?breadcrumb=%2Fissue%2F104%2Frule_of_law#7
13. Ernest George Ravenstein: *The Laws of Migration*, 1885. By John Corbett in Center for Spacially Integrated Social Science Classics. http://www.csiss.org/classics/content/90
14. World Resources Institute, United Nations Environment Programme, *Tomorrow's Markets, Global Trends, and Their Implications for Business.* 2000. Paris
15. Hansen, J. 2006. Climate Science Overview: *The Threat Posed by Global Warming.* Briefing to the Military Advisory Board of the Study of the Impacts of Global Climate Change on National Security.
16. Reuveny, R. *Environmental Change, Migration and Conflict: Theoretical Analysis and Empirical Explorations.* International Workshop on Human Security and Climate Change, Oslo, June 21-23, 2005. http://www.cicero.uio.no/humsec/papers/Reuveny.pdf
17. Wolf, A. T., and A. Kramer, A. Carius, G. Dabelko. July 2006. *Water Can Be a Pathway to Peace, Not War.* Woodrow Wilson International Center for Scholars, No. 1. http://www.wilsoncenter.org/topics/pubs/NavigatingPeaceIssue1.pdf
18. Conca, K. November 2006. *The New Face of Water Conflict.* Woodrow Wilson Center for International Scholars, No. 3. http://www.wilsoncenter.org/topics/pubs/NavigatingPeaceIssue3.pdf
19. Messer, Ellen, and M. Cohen and T. Marchione. ECSP Report (7): 1-16. http://www.wilsoncenter.org/topics/pubs/ECSP7-featurearticles-1.pdf
20. Kenyatta University, Professor Michael Bernard Kwesi Darkoh, "*Desertification: the scourge of Africa*" at http://www.cru.uea.ac.uk/cru/tiempo/issue08/ desert.htm
21. Helldén, Ulf. *Desertification Monitoring: Is the Desert Encroaching?* Remote Sensing Laboratory, Department of Physical Geography, University of Lund, Sweden. http://www.ciesin.org/docs/002-178/002-178.html
22. Hansen, J. et al. 2006. *Global Temperature Change.* Proceedings of the National Academy of Sciences vol. 103, no. 39: 14288-293. September 26, 2006
23. South African Weather Service, http://www.weathersa.co.za/Pressroom/2000/2000FebTCElne.jsp
24. Intergovernmental Panel on Climate Change, Third Assessment Report, 2001. *Climate Change 2001—Working Group II: Impacts, Adaptation and Vulnerability.*
25. U.S. Department of Agriculture. 2002. *China's Food and Agriculture: Issues for the 21st Century.* Market and Trade Economics Division, Economic Research Service, Agriculture Information Bulletin No. 775. April 2002. Fred Gale, editor
26. Bhattacharya, S. 2003. *European Heat Wave Caused 35,000 Deaths.* New Scientist 13:38. October 10, 2003
27. Lester R. Brown. 2006. *Plan B 2.0: Rescuing a Planet under Stress and a Civilization in Trouble.* New York: W.W. Norton & Co.
28. Gurdak, J., *Understanding groundwater response to human- and climate-induced stresses: High Plains Aquifer, United States.* U.S. Geological Survey. http://ca.water.usgs.gov/nawqa/hpgw/meetings/GURDAK5.html
29. National Academy of Sciences. 2007. Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability. Committee on the Scientific Bases of Colorado River Basin Water Management, National Research Council
30. Knutson, T., Geophysical Fluid Dynamics Laboratory, National Oceanographic and Atmospheric Administration. "Global Warming and Hurricanes." http://www.gfdl.noaa.gov/~tk/glob_warm_hurr.html
31. Weiss J. L., J. T. Overpeck. 2006. *Climate Change and Sea Level.* http://www.geo. arizona.edu/dgetl/index.html
32. Purvis, N. and J. Busby. 2004. *The Security Implications of Climate Change for the UN System.* ECSP Report. Issue 10.
33. Pittenger, R., and R. Gagosian. 2003. *Global Warming Could Have a Chilling Effect on the Military.* Defense Horizons, Number 33, October 2003
34. Center for Naval Analyses, CRM D0008026.A2/Final. 2003. *Susceptibility of Carrier Flight Deck Crewmen to Heat Stress* (U). A. Jewell, T. A. Roberts, K. M. DeBisschop. March 2003
35. U.S. Navy, Office of Naval Research, Naval Ice Center. 2001. *Naval Operations in an Ice-Free Arctic: Symposium.* April 17-18, 2001.
36. U.S.-Canada Power System Outage Task Force. 2004. *Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations.* April 2004. https://reports.energy.gov/
37. Boot, Max. *Our Enemies Aren't Drinking Lattes.* 2006. Los Angeles Times, July 5, 2006
38. Department of Defense, Defense Science Board. 2001. Task Force on Improving Fuel Efficiency of Weapons Platforms. *More Capable Warfighting Through Reduced Fuel Burden.* January 2001
39. The MITRE Corporation, JASON Program Office. 2006. *Reducing DoD Fossil-Fuel Dependence.* Report # JSR-06-135. September 2006
40. Earth System Research Laboratory, Global Monitoring Division, National Oceanogeaphic and Atmospheric Administration (NOAA). *Trends in Atmospheric Carbon Dioxide.* http://www.cmdl.noaa.gov/ccgg/trends/
41. Intergovernmental Panel on Climate Change, Third Assessment Report, 2001. *Climate Change 2001—Working Group I: The Scientific Basis.*
42. Gore, Albert. 2006. *An Inconvenient Truth.* New York: Rodale Press.
43. Emanuel, K. 2006. *Hurricanes: Tempests in a Greenhouse.* Physics Today: 74-75, August 2006
44. Arctic Climate Impact Assessment (ACIA). 2004. *Impacts of a Warming Arctic: Arctic Climate Impact Assessment.* Cambridge University Press. http://www.acia.uaf.edu
45. Trivedi, B. 2002. *Antarctic Gives Mixed Signals on Warming.* National Geographic Today, January 25, 2002
46. Vaughan, D. G. 2005. *How Does the Antarctic Ice Sheet Affect Sea Level Rise?,* Science 308, 5730, June 24, 2005: 1877–78.
47. National Oceanic and Atmospheric Administration, National Climatic Data Center. 2005. *Observed Trends and Variability in Land and Ocean Surface Temperatures.* February 8, 2005, http://lwf.ncdc.noaa.gov/oa/climate/research/trends.html
48. James C. Orr, Scott Doney, et al. 2005. *Anthropogenic Ocean Acidification Over the Twenty-first Century and Its Impact on Calcifying Organisms.* Nature 437: 681-686. September 29, 2005
49. Intergovernmental Panel on Climate Change, IPCC *Special Report: Emissions Scenarios, Summary for Policymakers.* 2000
50. National Academy of Sciences. Committee on Abrupt Climate Change. 2002. "*Abrupt Climate Change: Inevitable Surprises.*" Washington, D.C.: National Academy Press.



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Admiral GAFFNEY. The report on security and climate change does not judge whether or how much climate is changing, does not judge whether mankind is responsible for it or whether humans can turn it around. Rather, it points to the international and regional security consequences of climate change if the disturbing environmental signals that we have been measuring in our sophisticated last few years continue unabated.

The report likens the threat of climate change to that of the strategic threats we endured during the Cold Wars in that the probability of disastrous climate change cannot be determined with absolute certainty; but the effects of climate change, if current trends continue, on international security can be so great that one must prepare—plan, if you will—to deal with that.

It finds that the least developed nations of the world are most likely to be affected by climate change phenomena and the least likely to be able to cope with it eventually or even start to adapt to it now. In the report, we call for deliberate planning by the U.S. security organizations, meaning combatant commanders, intelligence agencies, et cetera.

I personally think that it is most useful if the climate science community at large can be as specific as possible in predicting climate change regional effects. Climate change may prove to be a global phenomenon, but it will be, I think, far from average. In some regions it will be much warmer, in others, much colder, especially if we have an abrupt climate change event, as has been discussed over the last 5 or 6 years, in the North Atlantic. In places it will be wetter, other places drier, some places stormier, et cetera. The question is, what will those changes be regionally so that U.S. security leaders can deliberately include expected results, predicted results in their plans?

To that end, I have seen the value of leveraging the talent, sensors, analytical and computational capabilities, and the data collected and the data archived by the defense and intelligence agencies. I saw that specifically and firsthand throughout the 1990s, from about 1991 through 2000, as a participant with MEDEA and its related groups.

I see some benefits, previously unreleased data and information from national security systems. National technical means, if you will, and others may help climate scientists at large get a fuller or clearer picture of what is going on in nature. And it is important, I think, increasingly, as we wrestle with climate change predictions; it is also important as we craft regionally specific plans.

And secondly, scientists and decision makers within the national security community may get better insight into their own security-mission-related challenges, not necessarily affected by climate change at all, by conferring with top civil scientists who have received security clearances and have access to capabilities.

Certainly, deliberate acts of reviewing and releasing data or deriving unclassified products from that data, from unreleasable data will cost something. But such costs would be considerably less than replicating data collection otherwise.

This cost-benefit point is more important when one considers the stakes involved in either underestimating the effects of, or overreacting to, climate change or their security-jeopardizing regional ef-

fects. If I can quote from former Speaker Newt Gingrich in his recent book, we cannot afford to be wrong about climate change. If national security leaders are to make actionable regional security plans that consider climate change, they need to know with the highest available degree of specificity the effects for their respective theaters.

In these most troubled parts of the world that we worry about most, governments are probably not prepared and maybe not willing to collect sophisticated, long-time, serious data. Yes, the successes of MEDEA are about a decade old, and many new sensors have come into being in the civil and the commercial world. I have recently seen unclassified compilations of open source collectors that can help us monitor the environment in this particular case. But the national security communities may have different flexibilities in satellite orbits, undersea access, resolutions, just a couple of examples. And they may also have and probably have useful archives that go back years and generations to fill in gaps. It is worth a look, I think.

The climate change debate is serious. Potential effects are also serious. And for regional security reasons, we should plan for it. But to plan we need to use the best measurements and the best data. We should leverage our best sources from all agencies.

Thank you.

[The statement of Admiral Gaffney follows:]

Testimony of

Paul G. Gaffney II (Vice Admiral, U.S. Navy (Ret.))

President, Monmouth University

Before a Joint Hearing of the

House Permanent Select Committee on Intelligence

Subcommittee on Intelligence Community Management

and

House Select Committee on Energy Independence and Global Warming

U.S. House of Representatives

Washington, DC

June 23, 2008

Dear Chairwoman Eshoo, Chairman Markey, Congressman Rush Holt (my Representative) and Members of the Committees:

Thank you for the opportunity to appear this morning at this joint hearing of your Committees. I am honored by your invitation to discuss briefly the national security implications of climate change and to provide you with thoughts about some steps that the Federal government can take to more specifically measure climate change indicators.

In sum, my recommendations to the Committees are two-fold:

1. The Federal government must plan seriously for the potential impact of environmental effects on both the nation's security and the security of regions around the world; and,
2. To help ensure that environmental threats are properly understood, we should use all applicable national investments and technical capabilities to measure, with specificity, when we can, the most critical physical processes of our planet.

These issues are, in my opinion, intertwined and mutually supportive. I have come to these conclusions as a result of related work in positions which I have held since 1991: Commander of the Naval Research Laboratory; Commander of the Naval Meteorology and Oceanography Command; Chief of Naval Research; Member of *MEDEA* (a group of government and cleared U.S. civil scientists, sponsored by the government, that focused on earth measurements using all sources of information) and its U.S. Environmental Task Force (ETF) and its related Environmental Working Group (EWG) within the "Gore-Chernomyrdin Program;" Member of the Military Advisory Board of the 2007 CNA Study "National Security and the Threat of Climate Change" (hereinafter the "2007 CNA Report"); President of the National Defense University; Commissioner during the full term of the U.S. Ocean Policy Commission; Member of the Joint Ocean Commissions Initiative; and presently as Vice Chair of the statutory Ocean Research / Resources Advisory Panel (ORRAP) and President of Monmouth University.

The need to focus the proper attention on environmental threats and studying the Earth's critical physical processes has only become more urgent by the climate change discussion. To explain the reasoning behind my recommendations, I would like to discuss briefly the findings of the 2007

CNA Report and, then, opine on the power of leveraging Defense and Intelligence data to both better measure the progress (or even the non-progress) of global climate change and inform climate change policy.

I was a member of the Military Advisory Board (a group of eleven retired three- and four-star generals and admirals from each of the military branches) that sat with CNA as it developed its Report on the national security implications of climate change. I support the Report's discussion, findings and recommendations and present my own narrow view of one aspect of the Rreport as recorded on the Report's 23rd page. Further, I applaud CNA for its timely attention to this, heretofore, largely unaddressed aspect of climate change. Chairwoman/Chairman: I would like to present the 2007 CNA Report for the record, along with my testimony.

The Report, like the new NIA on security and climate change, does not judge whether climate change is occurring, whether mankind is responsible for it or whether humans can turn it around. Rather, it points to the international and regional security consequences of climate change if the disturbing environmental signals measured in recent years continue unabated.

The CNA Report likens the threat of climate change to that of the strategic threats we endured during the Cold War, that is: while the probability of disastrous climate change cannot be determined with certainty, the effects of climate change (if current trends continue) on international security are so great that one must prepare to deal with severe security consequences. First principle: whether one believes climate change will happen or not, the effects if it does happen are dangerous enough that security forces must plan for it.

Within the Report, we cite water and water-related issues (such as: drought, famine, flooding and disease and resultant migration of rather desperate peoples) as major threats to regional security, globally.

The CNA Report finds that the least developed nations of the world are most likely to be affected by climate change phenomena and are least likely to be able to cope with them.

In the Report we call for deliberate planning by U.S. security organizations including the Defense, Intelligence and diplomatic communities. I personally think it is most useful if the climate science community, both from inside government and outside, can be as specific as possible about regional effects. Global climate change may prove to show an overall average warming of global air and sea temperatures, but global climate change is far from average. In some regions it can be warmer, others much colder (especially if an abrupt climate change scenario occurs in the North Atlantic). Some areas could witness more rain or sea level rise; both imply flooding. In still other areas, we could see drought and inevitable famine.

I think the CNA Report correctly frames a fundamental security construct for our future: adverse environmental conditions created by climate change, if unabated, will affect the least developed nations first, and whether it is too much water or too little, the intermediate results will be trans-national migrations of desperate peoples who are trying to survive which will lead, finally, to regional strife.

The question is: where will the effects of climate change be seen and what will those changes be so that U.S. security leaders can deliberately include expected effects in their regional plans? Second

principle: Understand more specifically, through better measurements, what is going on with climate change especially in key natural environments (such as: the Arctic, desert fringe environments, low lying coastal areas, historical breadbasket regions and glaciers) and geopolitically sensitive areas (such as: the Subcontinent, sub-Saharan Africa, Middle East and China).

I have recently heard that the National Academies organization, with the personal leadership of its President, Dr. Ralph Cicerone, is working to establish indices and metrics to inform future long term requirements for measurements of change on our planet.

As I mentioned earlier, the U.S. security community, specifically, needs to understand where climate change effects have the highest potential to affect regional security. The nation, generally, needs to understand if climate change is progressing. And, if the nation takes any policy steps to stem perceived climate change, it needs to know whether those steps (policy, lifestyle or investment changes) are having any impact.

To this end I remain confident that the Defense and Intelligence communities can and should be leveraged by the U.S. civil climate science community to better understand perceived climate change signals.

I have seen the value of leveraging the talent, sensor/analysis/computational capabilities, global presence, and data collected (or to be collected) and archived by these government agencies. I saw it during the period 1991- 2000 while *MEDEA* and its related groups were in action. Two general benefits derive for such undertakings:

1 previously un-released data and information from national security systems may help civil scientists get a fuller or clearer picture of what is going on in nature, and

2 government scientists and decision makers from the security community may get a better insight into their own mission-related challenges by conferring with top civil scientists who have received security clearances.

The following is a sample list of techniques that could be (have been) used in civil-government collaborations that are designed to cross security boundaries:

- Data can be simply released if deemed no longer classified; it may never have been classified or outlived its classification and just never been released.
- Raw data can be declassified, after very deliberate review following carefully structured processes.
- Useful unclassified information can be derived from classified, un-releasable data.
- Defense and Intelligence scientists can confer continually with appropriately (and rigorously) cleared civil climate scientists so both sides can benefit.
- Future space, ship, submarine, aircraft and *in situ* sensor collections can consider both mission-agency and environmental needs in system design, operational employment decisions and data distribution.
- "Fiducial sites" (i.e., geographic sites predetermined as scientifically important to observe) can be set up at which measurements from every possible civil, commercial and classified sensor can be made, repeatedly, over long time periods --- allowing climate change to be

actually measured, not just estimated. An example is recently released sea ice imagery from the Arctic.

Certainly, the deliberate acts of releasing data or deriving unclassified products from un-releasable data sets will require additional security processing and actual environmental analysis work, but such costs will be considerably less than replicating data collection missions, perhaps too late.

This cost-benefit point is more important when one considers the stakes involved in either underestimating the effects of or over-reacting to global climate change or their security-jeopardizing regional effects. I would make the same comment about costs to appropriately clear and keep updated a few dozen of the nation's top climate scientists who would work with government scientists with all data and all talent available to both.

If national security leaders are to make actionable regional security plans that consider climate change, then they need to know, with a higher degree of specificity, the probable climate change effects for their respective regions/theaters. In those troubled parts of the world about which we worry most, indigenous populations and governments are not prepared (or not willing) to collect sophisticated, long-time-series data necessary for measuring climate change speed, magnitude or direction. We may get more precise data, incidental to other mission-related collection efforts, in the regions where it has been least collectable by "open source" means, if we leverage existing and planned Defense and Intelligence assets more fully.

Yes, the successes of *MEDEA* are about a decade old and many new sensor systems have come into being in the civil and commercial world. I have recently seen a comprehensive unclassified

review of "open source collectors" that can help us monitor the environment. Yes, again, we do have access to more "open" information, but the national security communities may have different flexibilities in satellite orbits, resolutions and undersea access, for example. The Defense and Intelligence community may also have useful archives going back generations and regional specialists who can add to specificity determinations and understanding.

I would like to close with a general comment about potential U.S. national policies and investments to stem perceived climate change. Climate change is probably occurring, as it has so many times over the geological history scale. Man may have created it or may be contributing to it. Man may be able to turn it around. May, may, may. But, if our government makes substantial policy decisions regarding climate change that substantially consume our wealth or substantially change our life quality, then we have an obligation to use every asset at our disposal to determine if those "substantial policies" are bearing fruit.

The CHAIRMAN. Thank you, Admiral Gaffney, very much.

Ms. ESHOO. Mr. Chairman? Can I ask that the CNA report in its entirety be placed in the record of our hearing today?

The CHAIRMAN. Without objection, so ordered.

The Chair recognizes next Lee Lane, who is a Resident Fellow at the American Enterprise Institute. Mr. Lane's research focuses on a range of issues related to climate policy, and he was the Executive Director of the Climate Policy Center from 2000 to 2007.

Mr. Lane, welcome.

STATEMENT OF LEE LANE, RESIDENT FELLOW, AMERICAN ENTERPRISE INSTITUTE

Mr. LANE. Thank you very much, Mr. Chairman. It is a great honor to be here. I would like to thank both chairpersons, the ranking members, and all the members of both committees for the opportunity to discuss these issues with you today.

I am Lee Lane. I am Resident Fellow at the American Enterprise Institute. AEI is a nonpartisan, nonprofit organization conducting research and education on public policy issues. AEI does not adopt institutional positions on issues, and the views that I am going to express here this morning are solely my own.

I think the committees are to be commended for addressing the issues covered in this hearing. Climate change is one of the most important and certainly one of the most difficult problems facing the world. I have worked for the last 8 years on developing economically efficient solutions to this. I think all of us are concerned with American national security, so the committees have clearly focused on matters of prime importance and the intersection of two very important concerns.

My remarks really can be summarized in three points, which I would like to do, briefly, here.

First, climate change poses a very serious long-term problem. However, I have questions about whether looking at it through the lens of national security may not provide something less than the most useful perspective for viewing it. Some have worried that by worsening environmental and resource problems in very poor nations climate change may pose a risk to U.S. national security. Ecological problems in poor countries are, in fact, troubling, and for many points of view; but within the next 20 years or so, expected global warming is likely to have only a fairly modest effect on these problems, all of which would exist were no warming expected to occur whatever.

Moreover, as many distinguished economists have pointed out, in the near-term, efforts targeted at directly alleviating the underlying environmental stresses and poverty are likely to be far more cost-effective than attempts to reduce greenhouse gases will be. That is not to say that reducing greenhouse gases isn't extremely important in the long run, but—and this is my second point—a balanced climate policy requires careful consideration of both the costs of mitigation and its benefits.

Imposing very rapid emissions cuts are likely to impose significant burdens on the American economy. But more importantly still, if China and India don't join in efforts to curb emissions, our sacrifices will leave little or no environmental benefit.

Furthermore, attempts to use trade sanctions to coerce China and India and other nations to adopt greenhouse gas limits seem to me to be likely to add to international conflict, not to alleviate it.

Finally, some of the technologies that look to be important as potential solutions to the problem of climate change carry risks of their own. Certainly a substantial expansion of nuclear power raises questions and concerns about proliferation, as Chairman Markey has already alluded to. And expanding biofuels production, if that indeed turns out to be part of the solution, raises the specter of squeezing global food supply, another serious problem.

The real point I am trying to make here is just that trade-offs are inevitable in climate policy, and that is part of why it becomes such a difficult policy problem.

Third, new technologies will be the key to success, but halting climate change requires zero net emissions from the global economy. Zero net emissions. Today's technologies are not even close to being able to meet this goal at reasonable costs, nor will incremental improvements in those technologies suffice.

Devising new, transformational technologies and diffusing them globally could easily consume the remainder of this century. As time passes and emissions continue, the risk grows that high-impact, abrupt climate change might appear.

I will simply conclude, since I notice my time has expired here, by noting that there is possibly a family of technologies that might be able to produce a rather rapid global cooling even in a high greenhouse gas world.

The CHAIRMAN. We will come back to you in the question-and-answer period.

Mr. LANE. Okay.

The CHAIRMAN. Thank you.

[The statement of Mr. Lane follows:]

National Security Implications of Climate Change

Hearing of

The Permanent Select Committee on Intelligence and the House Select Committee on Energy Independence and Global Warming

By

Lee Lane

Resident Fellow

American Enterprise Institute

June 25, 2008

Mr. Chairman, members of the Committees, thank you for the opportunity to appear before you today to discuss the issues of climate change and national security. I am Lee Lane, a Resident Fellow at the American Enterprise Institute. AEI is a non-partisan, non-profit organization conducting research and education on public policy issues. AEI does not adopt organizational positions on the issues that it studies, and the views that I express here are my own, not those of the organization.

The committees are to be commended for addressing the issues covered in this morning's hearing. They are clearly of great significance. I regard climate change as one of the most difficult issues facing the world and have worked for the last eight years on developing economically efficient solutions to it. All of us, I think, are concerned with America's security and that of its citizens. So the committees have certainly focused on matters of prime importance to the American people.

Summary

My remarks address three points:

First, climate change poses a serious long-term problem for the U.S. and the world. However, viewing it through the prism of national security may not provide the clearest and most useful perspective from which to think about the difficult trade-offs that it presents. Some have worried that by worsening environmental and resource problems in very poor nations, climate change may pose a risk to U.S. national security. Ecological problems in poor countries are, in fact, troubling for many reasons, but within the next twenty years or so, expected global warming is likely to have only a modest effect on them. Moreover, as many distinguished economists have pointed out, in the near term, efforts targeted at directly alleviating the underlying environmental and poverty problems are likely to be far more cost-effective in reducing problems than attempts to reduce greenhouse gases (GHGs) will be.

Second, from whatever perspective climate policy is viewed, it entails trade-offs. Achieving a balanced policy requires careful consideration of the costs of mitigation as well as its benefits. Greenhouse gas output must be curbed, but hasty, unilateral cuts will impose significant burdens on the American economy. If China and India do not join the effort to curtail emissions, it will yield little environmental benefit. And attempts to use trade sanctions to coerce China, India, and other nations on GHG limits will surely add to international conflict, not alleviate it. Finally, some of the technologies suggested as possible solutions to climate change, themselves, prompt concerns. A large expansion of nuclear power would fuel proliferation worries, and by expanding bio-fuels we may squeeze global food supply. Trade-offs are unavoidable.

Third, new technology is the key to success. Halting climate change requires a zero net emission global economy. Today's technologies are not close to being able to meet this goal at reasonable costs, nor will incremental improvements suffice. But devising transformational technologies and diffusing them globally could easily consume the remainder of this century. As time goes on, the risk grows that high-impact abrupt climate change might appear. It would, therefore, be prudent for government to explore

the various novel technologies that many scientists believe might produce significant global cooling in a high-GHG world. At this point, these technologies remain speculative. But having them available might provide a vital margin of safety during the long transition to an emission-free global economy.

Climate change and security

The long-term concern

As a humanitarian and economic problem, climate change deserves serious attention. The harmful effects of climate change will be hit hardest in tropical Third World nations. There, climate change may add to water shortages or degrade quality. They may erode agricultural, forest, or marine productivity. Higher sea levels may restrict the supply of arable land. Higher temperatures may expand the range of tropical diseases.

As political scientist Thomas Homer-Dixon has observed, environmental pressures may prompt immigration or intensify social conflicts. They may worsen international tensions. Ultimately, legal order may collapse within states. Or ecological stress might trigger what Michael Klare has referred to as 'resource wars' over water, oil, land, or other sources of wealth. In principle, by aggravating the existing strains on resources, climate change may add to the levels of strife.

Gradual climate change and national security

Nonetheless, during the next twenty years, climate change is likely to stay of only secondary importance. Climate changes more slowly than do most of the other factors affecting national security. If we think of the next twenty years as the planning horizon for national security, the warming projected by the IPCC seems, in comparison with likely changes in economics and politics, relatively modest.

A backward look may illustrate the point. Compare today's political, economic, and technological environments with those of 1988. The changes are dramatic. To be sure, climate, too, has changed, but by comparison with, say, the fall of the Soviet Union or the rise of China, that change is marginal. Warming may well accelerate slightly during the next two decades. Even if it does, though, its pace will still lag far behind that of other major factors. Homer-Dixon, for example, sees climate change as posing a major threat only after the midpoint of this century or even later. In many poor countries, populations are growing, land is eroding, and water is becoming scarcer much more rapidly than the Earth's temperature is rising. And even if climate change were somehow halted, unless the direct sources of environmental stress are alleviated, the problems will go on worsening.

Other factors also complicate efforts to view global warming as a national security threat. For most national security purposes, global mean temperatures matter little. What do matter are regional and local conditions. Yet, the climate models are much less accurate in predicting regional results than they are in predicting global means. Then too, inter-decadal variations in the climate system can easily frustrate attempts to project climate

over shorter periods of time. Finally, environmental stress may be less important as a security threat than is sometimes assumed. As a source of international conflict, factors like government corruption or ineffectiveness may be more important than ecological ones. To select a case from the current headlines, there is really no point in trying to boost social order in Zimbabwe by limiting greenhouse gas emissions.

Policy implications

Climate change, of the kind we are discussing here, is potentially troubling primarily because it interacts with other environmental problems in parts of the Third World. These problems already exist. In principle, the rich countries could intervene to ameliorate them. Nobel laureate economist Thomas Schelling has often observed that these interventions would alleviate Third World problems more directly, more swiftly, and far more cost-effectively than a policy of reducing global GHG emissions. It is, for instance, already clear in Schelling's view that economic development is the best single remedy for the ills that climate change may visit on the Third World.

To expand on this point, the latest meeting of the Copenhagen Consensus group identified a series of targeted aid measures that would provide relatively fast and extremely cost-effective relief in many of the nations about which we are worried. These economists suggest that this aid could arrive much more quickly and pay higher dividends in poverty alleviation, and presumably social peace and stability, than emission reductions. If this view is correct, focusing our efforts on climate change would seem to be looking at the problems from the wrong end of the telescope.

Abrupt climate change

The above discussion focuses on gradual and continuous climate change. Faster change cannot, however, be entirely ruled out. In the past, climate has sometimes shifted in the course of a few decades. This has led to at least one effort to identify the national security effects of hypothetical abrupt high impact climate change. The problem with such exercises is that the science is too uncertain to allow for much useful analysis or policy planning. The experience of the 2003 report commissioned by the Pentagon's Office of Net Assessment illustrates the point. In this report, the authors asserted: "Rather than decades or even centuries of gradual warming, recent evidence suggests that a more dire climate scenario may actually be unfolding."

The report proceeded to sketch a series of Dantesque consequences. Of these, perhaps the most startling was that North America and Europe would be plunged into a climatic arid deep freeze. These predictions of imminent doom, however, drew scathing comments from the scientific experts, and the latest IPCC report finds that the consensus of the models is that Europe, far from freezing, is likely to continue warming throughout the 21st Century. It is hard to see how repeating the experience of the 2003 report is going to provide a more useful guide to future policy than emerged from that effort.

Mitigation strategies

Difficulty of global GHG abatement

As Scott Barrett of Johns Hopkins has commented, the task of forging an international agreement to curtail GHG emissions requires costly affirmative efforts by many nations, an especially difficult challenge for the international system. Yet international cooperation is essential for GHG controls to be effective. While the United States is a major source of greenhouse gas emissions, it is not the biggest. China is. China is also the fastest growing source. China, however, flatly refuses to curb emissions in any way that would slow its economic growth. So do other poor, but fast growing, nations.

Emissions from China, India, and similar countries are rising so rapidly that their growth is likely to swamp the effects of whatever America does. Thus, without the active cooperation of the Asian and South American nations, the U.S. and Europe cannot even prevent the continued growth of annual emissions. Yet the fast growing Asian countries have refused to accept the costs of controlling emissions, and at least some economic analysis suggests that they are being economically rational to continue doing so.

Problems raised by attempts to reduce emissions

This impasse has brought some in Congress to the point of considering trade sanctions as part of legislation to control domestic GHG emissions. Such provisions would clamp sanctions on China, India, and other countries that refuse to adopt GHG curbs. Clearly, this step would affect America's relations with the countries it sought to coerce. Whether the resulting conflicts would rise to the level of a national security concern is, I suppose, a matter of judgment. It would certainly put additional strains on the international trade regime. These implications of coercive climate diplomacy are worthy of consideration as part of the larger question.

Similarly, some of the technologies likely to become part of a GHG reduction strategy pose risks of their own. Nuclear power has certainly raised various security concerns. Biofuels now stand accused of worsening the global food crisis. In both cases, attempting to greatly expand the use of these technologies would encounter serious resource constraints. Future technological progress may erase these problems, or at least ease them. That such progress will occur and when is, however, unclear.

My point is not either anti-nuclear or anti-biofuels. I hope that both can play a part in the solution. Many other technologies will also be needed. Both technologies involve some risk. Climate policy is about balancing these risks against those of climate change whether or not we call the risks matters of national security.

The need for new technology

Without new technologies that lower the costs of cutting emissions, it seems hard to believe that a global consensus on reducing emissions is likely to form. Fortunately, the

long run outlook for new technology is fairly bright. Past funding for research in sciences that are potentially relevant to greenhouse gas reductions may mean that many new discoveries are already, "in the pipeline." And analysis done for the U.S. Department of Energy has shown that speculative, but plausible, progress on some key technologies could reduce the costs of stabilizing greenhouse gas concentrations by, literally, trillions of dollars.

A closer look, though, also suggests caution and patience. The technological solutions to climbing levels of greenhouse gases may be slower than we would hope and less than perfect when they arrive. It is worth examining four important reasons for believing that patience will be required.

First, solutions will require new scientific knowledge, not just new gadgets. The widely cited Hoffert *et al* 2002 *Science* article, observed that existing technologies and the expected extensions of them were wholly inadequate to the task of stabilizing greenhouse gas concentrations. The article also argued that nothing less than multiple large breakthroughs in basic science could create the revolutionary new technologies that were needed. However, *ex ante*, the outcome of R&D is notoriously uncertain. Will the progress envisioned by Edmonds materialize? If it does, when? There is far more doubt than would be the case were we considering the simple extension of existing technologies.

Second, a long lag often occurs between the discovery of new scientific knowledge and its first use in new processes or products. Another lag is common before the latter succeed in an engineering and economic sense. And the perfected innovation may take a long while to diffuse through the economy. Economist Nathan Rosenberg has explained very clearly why the process is so time consuming, but the upshot is that the full economic payoff of discoveries in basic science is often realized only after several decades.

Third, in the case of climate, the lags are likely to be especially long because the innovations must diffuse across most of the globe. Innovations made in America or Japan may not fit market and institutional conditions in China and India until they have been adapted to local conditions. Those conditions may differ widely from those prevailing where the invention originated. In climate technology, therefore, we might expect the diffusion process to be unusually long. An approach like carbon capture and storage, the use of which depends completely on government policy, may have an especially hard time in countries like China and India, where governments are most unlikely to foster it.

Fourth, at this point, we do not know what technologies are likely to meet the need. It may be space-based solar power. It may be nuclear with fuel recycling. It may be microbes that produce fuel. Or, to cite Jae Edmonds again, it may be something of which we cannot conceive until a future breakthrough in basic science opens our eyes to its possibility. One implication is that the problem here is quite different from that involved in the Apollo or Manhattan Projects. There, the scientists had a relatively clear concept of what they were looking for. Here, our vision of the goal is much cloudier.

However, many of the innovations needed to solve the climate problem depend on new discoveries in basic science. The economic rewards of such discoveries, although they can be very large for society as a whole, are notoriously difficult to capture for the organization that makes the discovery. As a result, a large gap develops between the level of private R&D investments and the level that would be optimal for society as a whole. Patents, tax credits, and subsidies are designed to remedy the resulting R&D shortfall, but apparently they are only partly successful. The gap between actual R&D investment and the optimal level appears to be large. In the U.S., for example, R&D investment is, according to some estimates, only about a quarter of the optimal level.

A possible additional approach

These considerations suggest that the technological means of low cost GHG emission cuts could be long in coming. As time goes on, the risk grows that high-impact abrupt climate change might appear—although the size of that risk remains highly uncertain. However, another family of technologies might provide an added margin of safety during the transition. The idea behind them is simple. When sunlight strikes the Earth's surface, greenhouse gases in the atmosphere trap some of the heat that is generated. A slight decrease in the amount of sunlight reaching the Earth's surface could, in principle, offset the warming. Scientists estimate that deflecting into space only 2 percent of the total sunlight that strikes the Earth would be enough to cancel out the warming effect of doubling the pre-industrial levels of greenhouse gases.

Scattering this amount of sunlight may be relatively easy. Past volcanic eruptions have shown that injecting relatively small volumes of matter into the upper atmosphere can scatter enough sunlight back into space to cause discernable cooling. The 1991 eruption of Mt. Pinatubo reduced global mean temperature by about .5 degree Celsius. These temperature reductions were apparent in just a few months and persisted for about three years.

Some scientists propose, therefore, to use modern technology to create a carefully engineered analogue to this effect. Proposals to seriously study geoengineering are gaining adherents among climate policy experts. In late 2006, NASA and the Carnegie Institution jointly sponsored a high level expert workshop on the subject. The workshop report observed that such distinguished scientists as Ralph Cicerone, Paul Crutzen, and Tom Wigley, have suggested further study, and it noted, "Prominent economists such as William Nordhaus and Thomas Schelling have long argued that the concept warranted further exploration as well."

I have included as Attachment A the Executive Summary of the NASA workshop. The promising although untried state of geoengineering strongly suggests that the federal government should do the R&D needed to explore this concept. Big questions persist, and experts continue to differ on the balance between the possible benefits and risks. Only research can resolve the outstanding uncertainties. In light of the long delays that may occur before significant progress on mitigation, an R&D investment in geoengineering seems prudent.

ATTACHMENT A

NASA/CP–2007-214558 **April 2007**

Workshop Report on Managing Solar Radiation

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Report of a workshop jointly sponsored
by NASA Ames Research Center and the
Carnegie Institution of Washington
Department of Global Ecology held at
Ames Research Center,
Moffett Field, California on
November 18 - 19, 2006

Executive Summary

In November of 2006 the NASA Ames Research Center and the Carnegie Institution of Washington, Department of Global Ecology at Stanford University sponsored an expert workshop on the use of solar radiation management as a strategy for coping with the challenge of climate change.

The basic concept of managing Earth's radiation budget is to reduce the amount of incoming solar radiation absorbed by the Earth so as to counterbalance the heating of the Earth that would otherwise result from the accumulation of greenhouse gases.

The workshop did not seek to decide whether or under what circumstances solar radiation management should be deployed or which strategies or technologies might be best, if it were deployed. Rather, the workshop focused on defining what kinds of information might be most valuable in allowing policy makers more knowledgeably to address the various options for solar radiation management. The report concludes with an appendix that describes important environmental science, engineering, and policy research issues.

Solar radiation management concepts

The volcanic eruptions of El Chichón and Pinatubo injected enough sulfate aerosol into the stratosphere to decrease temperatures in the Northern Hemisphere for 1 to 3 years by several tenths of a degree Celsius. Repeating the aerosol injections and optimizing them for cooling could amplify the impacts on global temperatures. Further research could assess whether this approach could safely counter the significant increases in temperature that could occur by 2100 if anthropogenic greenhouse gas emissions continue unabated. Research could determine, for example, whether injections of sulfates or other materials into the stratosphere could diminish cooling in the Arctic region, an area of seemingly high vulnerability to climate change.

Workshop participants also considered other approaches to solar radiation management, such as a plan to raise the reflectivity of low altitude marine clouds. Work has begun on designing seagoing hardware capable of producing the upward directed spray of mixed air and seawater intended to increase cloud reflectivity. Another proposed approach was to block some sunlight with an orbiting space sunshade. The inner Lagrange point L1 point is in an orbit with the same one-year period as the Earth, in-line with the sun at a distance where the penumbra shadow covers, and thus cools, the entire planet. A presentation on this concept proposed several approaches for overcoming the various engineering and economic challenges a sunshade presented although those challenges remain daunting.

These concepts have been the subject of some preliminary theoretical analysis, but none have been tested in the field under controlled experimental conditions.

Solar radiation management as climate policy

Research into solar radiation management approaches could develop information related to effectiveness and unintended consequences. Research could proceed in a carefully graduated series of theoretical studies and experiments. If the deployment of such technologies were ever to come under consideration, having generated detailed knowledge about the consequences of each option could be extremely valuable. On the other hand, research may show that solar radiation management strategies would not be feasible for any of a number of reasons.

Although the workshop did not address the issue of the circumstances under which solar radiation management should be deployed, participants' views on this matter appeared to span the gamut including (i) never, (ii) only in the event of an imminent climate catastrophe, (iii) as part of a transition to a low-carbon-emission economy, and (iv) in lieu of strong reductions in greenhouse gas emissions. More importantly, the discussion illuminated important differences in the economic and political implications of solar radiation management depending on whether deployment occurred in the face imminent climate emergency or was implemented preemptively well in advance of crisis conditions. Thus the circumstances under which solar radiation management might be deployed could have major implications for its economic and policy implications.

Possible risks, uncertainties, and objections

One major focus of the workshop was to identify the factors that might militate against research or deployment of solar radiation management technology. Participants noted several such potential objections. These included:

- Solar radiation management systems are unlikely to perfectly reverse all climate consequences of greenhouse gases and could introduce new changes in regional or seasonal climate, so some climate change might be expected even with the deployment of such systems.
- Modeling indicates that if a solar radiation management system were shut down suddenly after prolonged operation the climate system could warm very rapidly.
- Injecting sulfur into the stratosphere would likely diminish spring Northern Hemisphere stratospheric polar ozone levels, although the amount of diminution is currently uncertain and extreme Antarctic-style depletion is unlikely.
- Solar radiation management will neither reverse nor exacerbate non-climate effects of CO_2 including fertilization of the land biosphere and acidification of the ocean.

The workshop scope focused on preliminary characterization of some elements of a possible solar radiation management research program. Research into solar radiation management could have implications for other approaches to addressing climate change and could have various political consequences, both domestically and internationally. These considerations may be important, but were beyond the scope of our workshop.

The CHAIRMAN. Our next witness is Marlo Lewis. He is a Senior Fellow in the Competitive Enterprise Institute, where his work includes global warming and energy security. Dr. Lewis is no stranger to Capitol Hill, having previously served as Staff Director of the House Government Reform Subcommittee on Regulatory Affairs.

Welcome, sir.

Mr. LEWIS. Thank you, Madam Chairman and Mr. Chairman; it is a real honor for me to be here today.

Ms. ESHOO. Put your microphone on.

STATEMENT OF MARLO LEWIS, SENIOR FELLOW, COMPETITIVE ENTERPRISE INSTITUTE

Mr. LEWIS. Thank you. It is a real honor for me to be here today. Thank you very much.

My testimony develops two simple points. First, there are security risks associated with climate change, but also security risks associated with climate change policy. And that leads to my second point, which is that the Intelligence Community should assess not only the potential impacts of climate change on national security, but also the potential impacts of climate policies on national security.

Let's start with DOD, the single largest consumer of energy in the world. Rising energy costs already force DOD to economize in ways it never had to do in the era of $30 oil or even $60 oil. What happens if cap-and-trade programs push fuel costs even higher? Would DOD have to reduce the number and scope of training exercises, for example? Maybe not. But it is a risk.

And the Intelligence Community should assess it, consider a more fundamental risk. Money, an old adage tells us, is the sinews of war. Economic power is the foundation of military power. Economic might was critical to winning the Cold War and the Second World War and the First World War.

In democratic politics, moreover, there is always a trade-off between guns and butter. It is harder in bad economic times to raise funds needed to recruit, train, and equip the Armed Forces. Rising unemployment and malaise can foster isolationism.

The recently debated Lieberman-Warner bill would require a 70 percent reduction in U.S. greenhouse gas emissions by 2050. Other legislation would go further. Yet, as a forthcoming CEI analysis shows, for the economy to keep growing at 2.2 percent a year and achieve a 70 percent reduction in emissions would require U.S. carbon intensity to decline almost four times faster than it has over the historic period of the last 45 years.

So maybe, just maybe, big cuts in emissions can't really be achieved without big cuts in economic growth. If climate policy harms our economy, it could also sap our military strength.

We heard today that climate change could adversely affect natural resource availability, and we could see increased conflict among nations and within nations over resources like water and food. But climate policy also has a high potential to produce conflict.

Vice President Gore says the whole world must reduce its emissions 50 percent by 2050. Since most emissions' growth in the 21st century will come from developing countries, this goal may not be

achievable without, for example, prohibiting China and other developing countries from building coal-fired power plants.

Already some U.S. and European leaders are calling for carbon tariffs to penalize goods from China and India. Here is a warning: Trade wars don't always end peacefully. If America adopts this anticoal policy toward the world, we will continually butt heads with China and many other developing countries.

We have heard today that climate change could cause crop failure and food shortages and internal chaos in some countries. Well, during the past year food riots have broken out in more than 30 countries. In at least one instance, Haiti, rioters brought down the government.

And one factor fueling this crisis is a global warming policy, biofuel subsidies and mandates. We are only at the baby steps of this policy. If we ramp it up and, in addition, limit developing countries' access to fossil energy, we could possibly condemn millions to poverty and misery, not a good way to promote stability and peace in the world.

A much-touted study on abrupt climate change warned that a deep freeze in the North Atlantic would limit access to oil and gas and force poor nations to go nuclear, increasing the risk of proliferation. Well, a global moratorium on coal generation could do very much the same. Most cap-and-trade advocates are staunchly anti-nuke. But do they really suppose poor nations will consent to a ban on coal as an electricity fuel and not demand access to nuclear power?

We often hear that coastal flooding from sea level rise could create millions of refugees in low-lying countries like Bangladesh. But climate policy might actually make Bangladesh more vulnerable to sea level rise. In 2006, Bangladesh's economy was $55 billion and growing at 6 percent a year. At that rate, Bangladesh's economy will be $1 trillion in 2050 and $18.5 trillion in 2100, the miracle of compound interest.

But suppose——

The CHAIRMAN. Could you please summarize?

Mr. LEWIS. Okay, I will summarize.

If Bangladesh adopts a carbon tax and its growth rate falls by just 1 percentage point, its economy will be less than half the size in the year 2100, it will be less able to protect its citizens from sea level rise or handle other critical environmental challenges.

Thank you.

The CHAIRMAN. Thank you, Mr. Lewis, very much.

[The statement of Mr. Lewis follows:]

Statement of
Marlo Lewis
Senior Fellow
Competitive Enterprise Institute

House Permanent Select Committee on Intelligence
House Select Committee on Energy Independence and Global Warming

June 25, 2008

I. Introduction

Chairman Markey, Chairman Eshoo, Ranking Member Sensenbrenner, Ranking Member Issa, and Committee Members: Thank you for the opportunity to share my views on global warming and national security.

I am Marlo Lewis, a senior fellow in environmental policy at the Competitive Enterprise Institute (CEI), a free-market public policy group with a strong focus on global warming and energy, among other issues.

CEI has long argued that most public discussions of global warming unwisely ignore the significant health, safety, and environmental risks of climate change policies. This can lead to policy decisions that do more harm than good.

A classic case is fuel economy standards. The new mpg standards enacted in December 2007 will haven no measurable effect on global temperatures.[1] However, those standards will put motorists at risk by forcing auto manufacturers to make the average vehicle smaller, lighter, and, thus, less protective of occupants in collisions. The National Highway Traffic Safety Administration estimates that the current 27.5-mpg standard contributes to an additional 1,300 to 2,600 auto fatalities per year.[2] Congress's decision to require a 40-percent increase in average fuel economy by 2020 will, at a minimum, limit the safety gains that automakers could otherwise achieve.

A related example is biofuel policy. The European Union's biofuel directive, although adopted in the name of saving the planet, is bankrolling deforestation and habitat destruction in Malaysia and Indonesia. This not only threatens the Orangutan and several other species, it also contributes to the burning and clearing of peat lands, producing large net increases in greenhouse gas emissions.[3]

Global warming policies can also adversely affect human health and life expectancy. Rising energy costs are widely viewed as a key cause of the current economic downturn. Policies like Lieberman-Warner, which the U.S. Energy Administration estimates would raise gasoline prices an additional 41 cents to $1.01 per gallon by 2030,[4] would make a bad economic situation worse. The bigger loss, however, could well be in lives. As Harvey Brenner of Johns Hopkins University argues, the most important factors affecting disease and death rates are income, employment, and socio-economic status. Even short-term, year-to-year fluctuations in economic indicators can measurably affect mortality rates. By increasing the costs of goods and services such as energy, and decreasing disposable incomes, global warming "regulation can inadvertently contribute to poor health and premature death."[5]

Please note, I am not saying that global warming is a myth or that there are no health, environment, and safety risks associated with climate change. What I am saying is that there are also risks associated with climate change policy. Policymakers should assess and weigh both sets of risks before deciding on a course of action. In most public discussions, however, the risks of climate policy are not even acknowledged. We ignore the risks of climate policy at our peril.

II. Geopolitical risks of global warming policy

An egregious example of this one-sided approach was the October 2003 study for the Defense Department by Peter Schwartz and Doug Randall, entitled, "An Abrupt Climate Change Scenario and Its Implications for United States National Security."[6] The study hypothesizes what might happen to the global economy and international stability if the Atlantic thermohaline circulation shuts down and the climate rapidly deteriorates into ice age-like conditions. In page after pulse-pounding page, the authors describe a world convulsed by famine, food riots, water shortages, energy shortages, trade wars, mass environmental refugee migrations, and armed conflict within and among nations.

Schwartz and Randall even hint that abrupt climate change would make nuclear war more likely:

> In this world of warring states, nuclear arms proliferation is inevitable. As cooling drives up demand, existing hydrocarbon supplies are stretched thin. With a scarcity of energy supply—and a growing need for access—nuclear energy will become a critical source of power, and this will accelerate nuclear proliferation as countries develop enrichment and reprocessing capabilities to ensure their national security.[7]

The authors predictably recommend that DOD invest in modeling capabilities to forecast how and where abrupt climate change could occur, the impacts on global food, water, and energy supplies, and the implications for national security.

Notice what they leave out. The report does not consider whether climate change policy could adversely affect the U.S. industrial base, the combat readiness of U.S. armed forces, global food and energy supplies, or international stability. Nor does it advise DOD to assess these risks in future studies.

So let's consider some of the geopolitical risks global warming policies may create.

"Money," an old adage declares, "is the sinews of war." If we learned anything from the Cold War, it is that economic power is the foundation of military power. The Soviet Union imploded because it lacked the economic base to support its military and geopolitical empire. U.S. economic might was critical to winning the Cold War—as it was to winning World War I and World War II.

At the risk of belaboring the obvious, there is always in democratic politics a tradeoff between guns and butter. It is harder in tough economic times than in prosperous times to raise the funds required to recruit, train, and equip the armed forces. It is harder to sustain public support for military interventions abroad when unemployment and malaise are rising on the home front.

So to the extent that climate policies pose a risk to U.S. economic growth, they also pose a risk to U.S. military strength and defense preparedness.

In this light, let's consider the Lieberman-Warner bill, which would require a 70-percent reduction in U.S. carbon dioxide emissions by 2050. CEI commissioned University of Guelph economist Dr. Ross McKitrick to assess both the economic impacts of the Lieberman-Warner bill and the Energy Information Administration's analysis of the bill. The EIA estimates that up to 1 million manufacturing jobs could by lost by 2030.[8] However, this is likely an underestimate, because the EIA's reference case assumes rates of population growth, emissions growth, and income growth that are significantly lower than the long-term rates over the past 45 years.[9]

In his forthcoming paper, Dr. McKitrick explains that a society's total emissions are a product of three factors: population, per capita GDP, and the carbon intensity of production. To reduce aggregate emissions, it is necessary to reduce one or more of those three factors. And there's the rub.

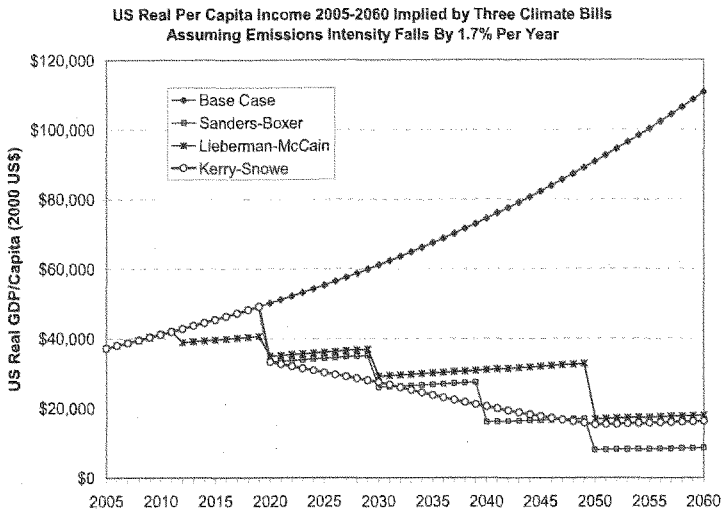
Population is growing at +1.1 percent per year. There is not much Congress can do about that. Real income is growing at about +2.2 percent per year, and presumably Congress wants that to continue. So to reduce emissions 70 percent by 2050, the other factor—emissions intensity—must decline by the following approximate amounts:

- 4.4% per year on average between 2006 and 2012
- 5.2% per year on average between 2006 and 2030
- 6.2% per year on average between 2006 and 2050

Dr. McKitrick comments: "There is no historical precedent for such rapid reductions in carbon dioxide intensity." Indeed, the historic rate of emissions intensity decline over the past 45 years is 1.6 percent per year.

If these somewhat miraculous reductions in carbon intensity do not occur, then the only way to reach the 70-percent emission reduction target will be through big increases in energy prices leading to big declines in economic growth. This is a recipe for stagflation and worse.

In another paper CEI has commissioned, Dr. McKitrick shows what happens to per capita GDP under several climate bills if population growth and emission intensity decline continue at their historic rates.



Instead of per capita GDP more than doubling between 2005 and 2060, it falls by half or more. The American dream becomes the American nightmare.

Does it have to happen that way? No. Technology breakthroughs that dramatically lower the cost of cutting emissions may occur. But it is in the nature of breakthroughs that they are difficult to plan or even predict. Thus, under these emission reduction mandates, there is a significant risk of severe economic damage.

So again let me state the obvious: An economically weakened America would be less able to sustain its defense commitments, keep the peace, and remain vigorously engaged in the world.

The top agenda item of many global warming activists today is stopping the construction of new coal-fired power plants. No new coal power plants should be built, we are told, unless they are equipped with carbon capture and sequestration. But it could take a decade to determine whether carbon capture and storage is economical under a range of emission reduction scenarios, years to

develop the regulatory framework for a carbon capture system, years to overcome NIMBY opposition, and a decade to build the infrastructure on an industrial scale.[10]

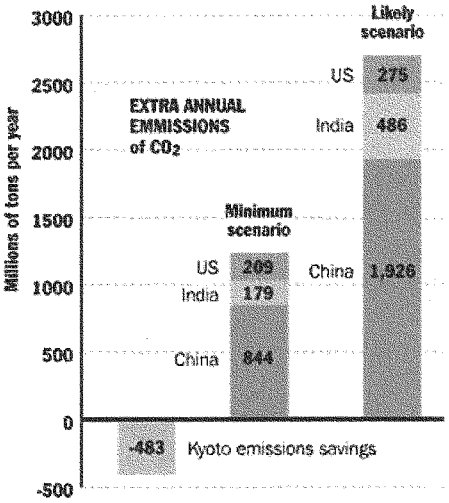
In the meantime, U.S. electricity demand is growing, and coal is the fuel of choice in many markets. The EIA forecasts that between 2007 and 2030, coal will provide 67 percent of all new electric generation in the United States, and new coal generation will constitute 15 percent of all U.S. electric power in 2030.[11]

Moratoria that effectively ban new coal-based power could create a severe supply-demand imbalance. This would not only inflate electricity and natural gas costs (demand for coal would be diverted to natural gas as an electricity fuel), it would also jeopardize electric supply reliability. Indeed, some parts of the country may experience chronic energy crises characterized by repeated power failures and blackouts.

From a national security standpoint, this poses two main risks. One is that America will increasingly resemble a Third World country where nothing works very well. We will lose our international prestige and ability to lead by example. The other risk is that terrorists will view America's over-stretched, failure-prone electricity grid as a tempting target. They may calculate: If America's electric supply system is tottering on the edge, why not give it a few helpful shoves?

The anti-coal campaign is, of course, not limited to the United States. Global warming activists seek to ban new coal-fired power plants not only here but also in China, India, and other developing countries. This is essential to their agenda, and for a very simple reason. The emissions from new coal plants here and elsewhere will swamp all of the emission reductions that Europe, Japan, and Canada might, in theory, achieve under the U.N. global warming

treaty, the Kyoto Protocol.[12] Either the global warming movement kills coal, or coal will bury Kyoto.

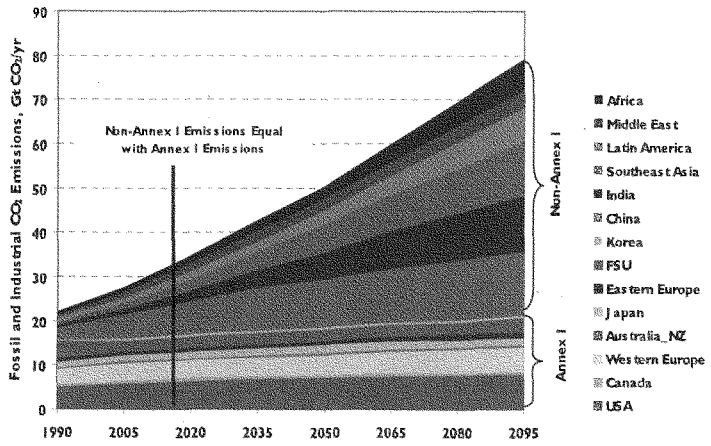


Source: Christian Science Monitor, 2004

The campaign to ban new coal worldwide raises additional national security concerns. First, how would a global moratorium on new coal plants be enforced, and by whom? Presumably this would be accomplished, initially, via trade sanctions. Already European and U.S. leaders are calling for carbon tariffs to penalize goods from countries like China and India that refuse to limit their emissions.[13] Warning: Trade wars are not always resolved peacefully! In any event, if the United States vigorously presses for a ban on new coal plants around the world, it will continually butt heads with China, India, and many other developing countries.

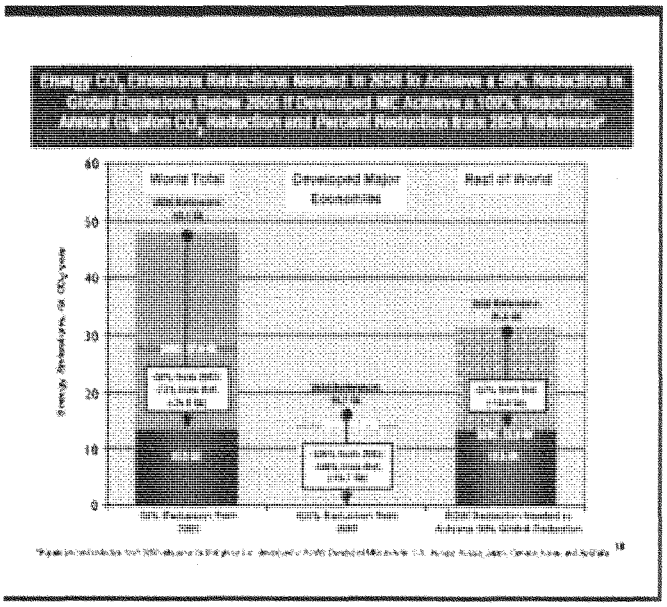
We often hear that the world must reduce global emissions 50 percent by 2050 to avert the more dangerous effects of global warming. Those who say this may not realize the kind of sacrifice they are asking developing countries to make. Almost all the

growth in emissions over the next few decades is expected to occur in developing countries.



Source: Department of Energy

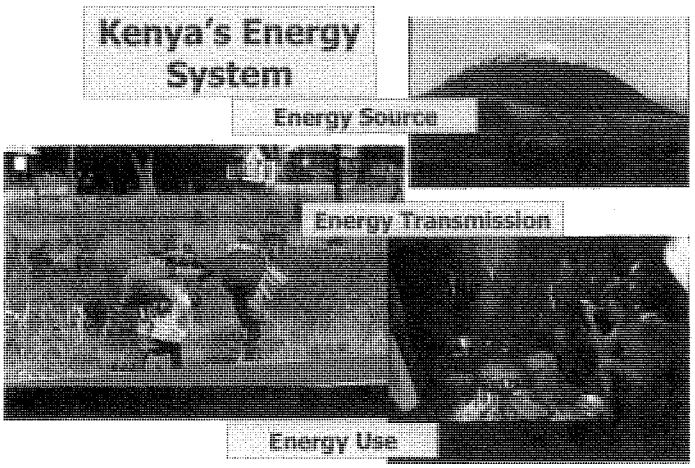
Analysis by the Department of Energy shows that even if the industrialized countries somehow go cold turkey by 2050 and achieve zero net emissions, developing countries would still have to cut their emissions 57 percent below baseline projections to reduce global emissions 50 percent below 2005 levels.



A great deal of political and, dare I say, military capital might have to be expended to bring the developing world into line with this agenda.

But assume the anti-coal policy triumphs. That would create another set of security risks. Much of the world is energy poor. An estimated 1.6 billion people have no access to electricity, and about 2.4 billion people still rely on traditional biomass—wood, crop waste, even dung—for cooking and heating.[14]

Kenya's "energy system" typifies the plight of millions of people around the world.



Source: Dr. John Christy

The "energy source" is wood chopped from the forest. The "energy transmission" system is the backs of women and girls, hauling the wood a U.N.-estimated average of 3 miles each day. The "energy use" system is burning the wood in an open fire indoors for heat and light.

These villagers breathe indoor air that is much dirtier than outdoor air in the world's most polluted cities. Respiratory disease among this large segment of humanity is rampant and kills more than a million people a year, most of them women and children. Reliance on traditional biomass also takes a heavy toll on forests and wildlife habitat.

A coal-fired power plant would improve the lives of those villagers in Kenya in many ways. Women would be freed from backbreaking toil and could pursue more fulfilling activities. People would be healthier because indoor air quality would

improve. Refrigeration would make food preparation easier and safer. Electric lighting would allow people to read and study at night. Computers and Internet access would follow. The beautiful forests and the species dependent on them would be saved.

Denying these people—and millions of others like them—access to coal-based power would be a humanitarian disaster. Some might even call it a crime against humanity. Trapping people in energy poverty will very likely make them hungry, desperate, and angry. The potential for conflict within and among countries under a global ban on coal-based power may be quite large.

Schwartz and Randall warn that abrupt climate change would cause food shortages and destabilize governments. Well, during the past six months food riots have broken out in more than 30 countries, and in at least one case—Haiti—rioters brought down the government.[15] Big jumps in the price of staples—corn, wheat, and rice—are pushing millions of people below the absolute poverty line.[16]

Today's food price inflation has several causes including a weak dollar, high oil prices, drought, and surging demand in India and China. But one factor fueling this crisis is a global warming policy—government subsidies and mandates for corn ethanol production.[17] Biofuels provide only about 1.5 percent of total motor fuel liquids, yet they accounted for almost half the increase in global consumption of major food crops in 2006-07, according to the World Bank.[18] More aggressive efforts to replace petroleum with biofuels could literally starve the hungry, creating chaos and conflict.

Schwartz and Randall warn that abrupt climate change will create millions of environmental refugees fleeing across borders to escape from hunger and water shortages. Millions of illegal migrants already cross the U.S. southern border from Mexico. Poor

Mexicans obtain 40 percent of their daily calories from tortillas, and the U.S. ethanol program, by inflating the price of corn, contributed to a "tortilla crisis" in Mexico.[19] Burning food in gas tanks exacerbates the poverty that is a root cause of illegal migration. Expect an increase in 'biofuel refugees' as the mandates ramp up.

Schwartz and Randall warn that abrupt climate change, by intensifying winter storms and expanding sea ice, could reduce the availability of gas and oil, leading to conflict over dwindling resources. Well, this implies that non-abrupt climate change, which is far more likely, could make gas and oil more available by opening up the long-sought Northwest Passage.[20]

More importantly, since Kyoto-style policies aim to restrict access to fossil fuels, they too have the potential to engender conflicts over energy. Cap-and-trade programs force participants to compete over slices of a shrinking pie. That is how cap-and-trade is supposed to work. When it doesn't work that way—as in phase one of the European Emissions Trading System—it is because companies and/or governments are cheating.[21]

As noted earlier, Schwartz and Randall warn that abrupt climate change could expand the use of nuclear power and endanger peace via proliferation. My guess is that a 50-percent global emission reduction target and a global ban on new coal plants would grow the nuclear industry faster than would abrupt climate change. I'm not fearful of nuclear power, but most environmental groups remain staunchly anti-nuke. Do they really suppose that poor nations will consent to ban coal as an electricity fuel and not demand access to nuclear power?

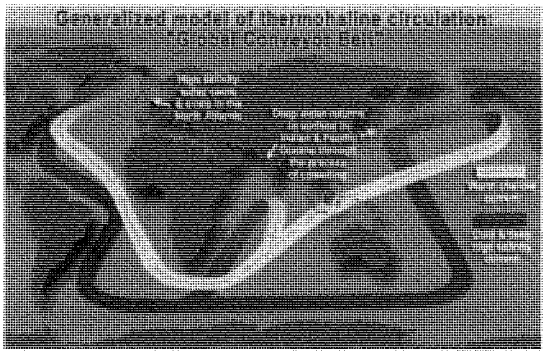
III. How plausible is the Schwartz-Randall abrupt climate change scenario?

The likely response to the foregoing is that even the most aggressive Kyoto-style policies would not endanger world peace and global stability as much as would abrupt climate change. I frankly do not know. Mandating 80- and even 90-percent reductions in U.S. emissions by 2050, as Vice President Gore advocates, mandating a 50-percent cut in emissions worldwide, banning new coal plants around the world, and attempting to enforce these policies through trade sanctions would, in my judgment, create endless conflicts and destroy America's leadership in the world.

But let's stipulate for the sake of argument that abrupt climate change is potentially a greater security threat. Nonetheless, if the Schwartz-Randall scenario is implausible, we would be unwise to adopt geo-politically risky policies in the hope of averting it.

The Schwartz-Randall abrupt climate change scenario goes as follows. Global warming increases the amount of fresh water entering the North Atlantic from glaciers, the Greenland ice sheet, rainfall, and river discharges. As the surface of the North Atlantic becomes fresher, it also becomes less dense. The less dense it becomes, the more slowly it sinks. Eventually—Schwartz and Randall conjecture as soon as 2010—it sinks too slowly to pull warm water up behind it from the tropics. The Atlantic branch of the thermohaline circulation, or THC,[22] popularly known as the oceanic "conveyor belt," shuts down. Average annual temperatures "fall by 5 degrees Fahrenheit over Asia and North America and up to 6 degrees Fahrenheit in Europe."[23]

How likely is this? Schwartz and Randall say this scenario is "plausible" because rapid cooling happened twice before in our current inter-glacial period, the Holocene.[24]



Some scientists believe that a sudden infusion of fresh water may have disrupted the conveyor belt and caused cooling events 12,800 and 8,200 years ago. But in both cases, this happened when giant ice dams—relics of the previous ice age—burst, allowing huge fresh water lakes to drain swiftly into the North Atlantic. An estimated 9,500 cubic kilometers of fresh water poured into the North Atlantic 12,800 years ago,[25] and more than 100,000 cubic kilometers 8,200 years ago.[26] The amount of ice melt from Greenland today is a comparative trickle—about 220 cubic kilometers a year.[27]

Is the THC slowing down? In 2005, Harry Bryden and two colleagues at the UK's National Oceanography Center reported a 30 percent decline in the THC's northward flow—only to announce one year later, after more data came in, that this was a false alarm.[28]

In 2006, Christopher Meinen and two colleagues at the Atlantic Oceanographic and Meteorological Laboratory in Miami found no change in the strength of the THC since the late 1980s. Similarly, a team of German scientists headed by Friedrich Schott found no change over the past decade.[29] Another group of mostly German scientists found an actual strengthening of the THC since 1980.[30]

In its Fourth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) summarized the scientific literature thusly: "Over the last 50 years, no coherent evidence of a trend in the strength of the meridional overturning circulation [THC] has been found."[31]

Finally, I would note that not all scientists believe that a shutdown of the Atlantic THC would have the catastrophic effects on Northern Hemisphere temperatures that Schwartz and Randall postulate. Richard Seager of Columbia University's Lamont-Doherty Earth Observatory argues that the key factor sustaining Europe's mild winters is a difference in the warmth of the prevailing winds that blow across northeastern North America and Western Europe. During the winter, "South-westerlies bring warm maritime air into Europe and north-westerlies bring frigid continental air into north-eastern North America."[32] If this finding is correct, then Europe should continue to enjoy mild winters even if global warming weakens the THC.[33]

IV. Catastrophic sea level rise

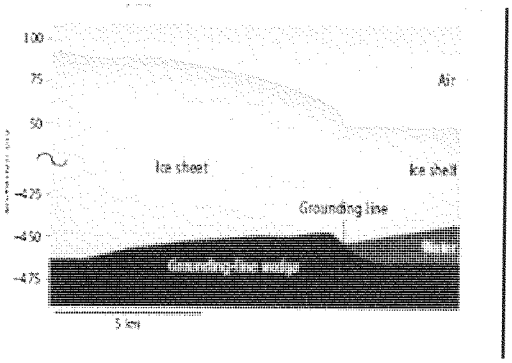
The thermohaline shut down scenario attracted a lot of media attention a few years ago, but today the scenario people worry about most is rapid sea level rise. In *An Inconvenient Truth*, for example, Mr. Gore suggests that sea levels could rise as much as 20 feet in our lifetimes or those of our children.

In the book version, Gore warns that, "If Greenland melted or broke up and slipped into the sea — or if half of Greenland and half of Antarctica melted or broke up and slipped into the sea — sea levels worldwide would increase by 18 to 20 feet." More than 100 million people living in Beijing, Shanghai, Calcutta, and Bangladesh would, he says, be "displaced," "forced to move," or "have to be evacuated." The World Trade Center Memorial would be "under water."

Well, yes, *if* half of Greenland Ice Sheet and half the West Antarctic Ice Sheet suddenly broke up or melted, these dreadful things would happen. The national security "implications" would also be profound. The U.S. armed forces would do little else besides evacuation and rescue operations.

But there is no evidence anything of the sort is likely to occur.

The West Antarctic Ice Sheet is actually more stable than scientists once believed, as *Science* magazine reported in 2007.[34] Scientists using radar imaging discovered a "miles-long pile of sediments as thick as 100 feet deposited beneath the Ross Ice Shelf over the last 1,000 years."



Source: Anderson (2007)

The Ross Ice Shelf is the southern portion of the West Antarctic Ice Sheet and the largest platform of floating ice in Antarctica.

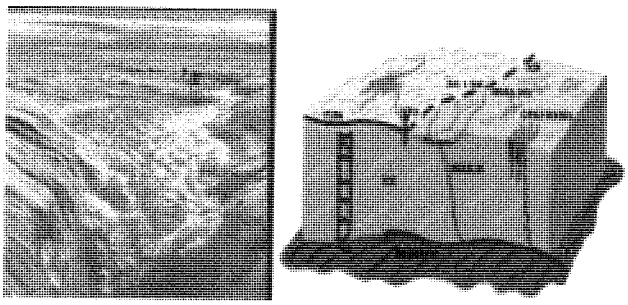
Previous research suggested that sea level rise of a few meters might float the ice shelf off its moorings, hastening its breakup and demise. Thanks to the stabilizing sedimentary deposits, the researchers now estimate sea levels would have to rise by 35 feet to float the Ross Ice Shelf. In other words, more than half the West

Antarctic Ice Sheet would have to fall into the sea to raise sea levels enough to cause half of it to fall into the sea.

Well, Gore also said half of it could melt. But that's not what the U.N. Intergovernmental Panel on Climate Change, the IPCC, is saying. In its 2007 report, the IPCC stated that, "Current model studies project that the Antarctic ice sheet will remain too cold for widespread surface melting, and gain mass due to increased snowfall."[35]

What about the Greenland Ice Sheet? Gore warns that melt water pools on the surface of the ice sheet form "moulins," vertical water tunnels that channel massive amounts of water down to the bottom of the ice. The moulins lubricate the bedrock on which the glacier rests. This process, says Gore, "destabilizes" the ice sheet.

To illustrate how moulins could destroy the Greenland Ice Sheet, Gore presented a photograph and a diagram from a study of moulins published in *Science* magazine in 2002.[36]



Source: Zwally et al. (2002)

In his film, Gore animates the diagram so that the ice sheet begins to split apart along the dashed line. However, the study in *Science* magazine did not hypothesize any such crack up. It found that moulins do accelerate glacial movement in Greenland in the

summertime, but only by a few percent. This means moulins add an extra 5 to 10 meters of movement to a glacier that otherwise would travel about 115 meters in a year. Keep in mind that the Greenland Ice Sheet is huge—about 2,500 kilometers long and 1,000 kilometers wide.

A 2008 study, also published in *Science*, provides additional evidence that moulins pose no threat to civilization.[37] The study found that the rate of glacial flow of several outlet glaciers in Greenland, including the biggest, Jakobshavn Isbrae, are "relatively insensitive" to the process of bedrock lubrication by moulins.

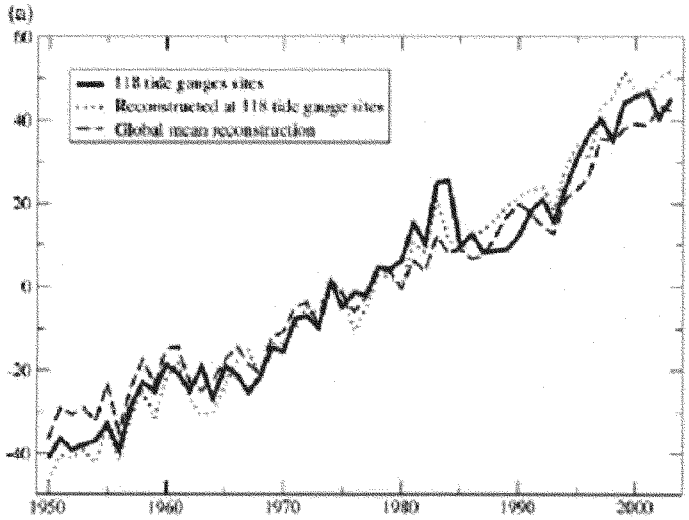
A companion article notes that an entire melt-water lake 4 kilometers long and 8 meters deep disappeared down a moulin in about 1.4 hours. The water rushed down the moulin "at an average rate of about 8,700 cubic meters per second, exceeding the average flow over Niagara Falls." Sounds terrifying, doesn't it? But, the article reports, "For all the lake's water dumped under the ice that day and all the water drained into new moulins in the following weeks, the ice sheet moved only an extra half-meter near the drained lake."[38] To repeat, the Greenland Ice Sheet is measured in thousands of *kilometers*.

Could global warming melt half the Greenland Ice Sheet, as Gore suggests? A modeling study reviewed by the IPCC in its 2001 report estimated that 5°C of additional warming would melt about half of Greenland's ice—over a thousand years.[39] Nobody can forecast temperatures that far into future. However, it's a safe bet that global energy infrastructure will have turned over many times long before then.

So how much sea level rise can we reasonably expect in the 21st century? The IPCC's 2007 report [Summary for Policymakers, p. 13] estimates a range of 0.18 to 0.59 meters, or 7 to 23 inches, with

a mean forecast of 14 inches. That's a far cry from Gore's 18-20 feet. Fourteen inches is about as much sea level rise as has occurred since the 1860s. Something else rose much faster—real estate values for beachfront property.

Although the IPCC sea-level rise estimate is much lower than Gore's, it may still be too high. A study published in the journal *Global and Planetary Change* found that global sea levels rose by 1.48 mm/yr from 1955 to 2003, with no acceleration during those five decades. That translates into 14.8 centimeters or 5.8 inches in a century.[40]



Source: Berge-Nguyen et al. (2008), Sea level rise, 1950-2003, in millimeters

No child should go to bed worrying about a 20-foot wall of water. Neither should the generals at DOD.

But let's assume sea level rise will accelerate through the 21st century, and that sea levels will rise close to the high end of the IPCC range of 7 to 23 inches. Here again, global warming policies could create more risk than they avert.

Consider the case of Bangladesh, a country with lots of land near and below sea level. Reason Foundation science correspondent Ronald Bailey notes that in 2006, Bangladesh's $55 billion economy was growing at 6 percent per year. If that growth rate continues, the Bangladesh economy will be $1 trillion in 2050 and $18.5 trillion in 2100. But now assume that the threat of trade sanctions induces Bangladesh to adopt a carbon tax, or that global restrictions on energy use slow global GDP growth, and Bangladesh's growth rate drops by just one percentage point, to 5 percent per year. In that case, the Bangladesh economy is only $630 billion in 2050 and $7.2 billion in 2100.[41]

A small reduction in the economic growth rate compounds into big long-term differences in national wealth. A poorer Bangladesh will have fewer resources to invest in education, health care, and, yes, protection from sea-level rise. Bangladesh could actually lose more land to sea level rise in a poorer cooler world than in a richer warmer world.

If defense intelligence analysts are going to examine the national security implications of the potential impacts of sea level rise on developing countries, then they should also consider the implications of climate policy choices that could impair the ability of countries like Bangladesh to protect themselves from sea level rise.

More broadly, defense analysts should consider the security implications of policy choices that by restricting trade, increasing energy costs, and slowing global GDP growth, impair the ability of

developing countries to solve persistent underlying problems—like hunger, malaria, and coastal flooding—that climate change might exacerbate.

V. Conclusion

The global warming debate suffers from a profound lack of balance. Proponents of carbon suppression policies spotlight, trumpet, and even exaggerate the risks of climate change but ignore or deny the risks of climate change policy.

This one-sided perspective dominates recent attempts to link global warming to national security concerns. The remotest possibility of abrupt climate change is seized upon as a rationale for policies with enormous potential to harm people, the economy, and, indeed, national security. This hearing will have served a valuable purpose if it begins to redress the balance.

Bio

Marlo Lewis, Jr. is a Senior Fellow at the Competitive Enterprise Institute (CEI), where he writes on global warming, energy policy, regulatory process reform, and other public policy issues. Prior to joining CEI, Marlo served as director of external relations for the Reason Foundation and as staff director of the House Government Reform Subcommittee on Regulatory Affairs. He has published in National Review, the Washington Times, Investors Business Daily, the American Spectator, Tech Central Station, Energy, Pollution Liability Report, and The Hill. He has appeared on various TV and radio programs including Oprah Winfrey, C-SPAN, CNBC Capital Report, CBC-News Marketplace, and BBC TV. He holds a Ph.D. in Government from Harvard University and a B.A. in Political Science from Claremont McKenna College.

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[1] John Christy, "My Nobel Moment," Wall Street Journal, November 1, 2007, http://online.wsj.com/public/article/SB119387567378878423.html. Christy estimates that even if the entire world adopted California's new emissions standards, which effectively set fuel economy requirements at 43 miles per gallon within the next decade, "the net effect would reduce projected warming by 0.05 degrees Fahrenheit by 2100, an amount so miniscule as to be undetectable."

[2] National Research Council, *Effectiveness and Impacts of Corporate Average Fuel Economy Standards* (2002), page 3, finding 2, http://books.nap.edu/openbook.php?isbn=0309076013&page=3

[3] Jonathan Lewis, Clean Air Task Force, Leaping Before They Looked: Lessons from Europe's Experience with the 2003 Biofuel Directive, October 2007, http://www.catf.us/publications/reports/Leaping_Before_They_Looked.pdf

[4] Energy Information Administration, Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007, p. viii, http://www.eia.doe.gov/oiaf/servicerpt/s2191/pdf/sroiaf(2008)01.pdf

[5] Harvey Brenner, The Health Benefits of Low Cost Energy: An Econometric Case Study, Air and Waste Management Association Forum, 2005, http://www.ccednet.org/docs/Brenner%20Coal%20Case%20Study%20Nov05.pdf

[6] Peter Schwartz and Doug Randall, An Abrupt Climate Change Scenario and Its Implications for United States National Security, October 2003 (hereafter cited Schwartz and Randall). The study is available at http://www.climate.org/PDF/clim_change_scenario.pdf

[7] Schwartz and Randall, p. 19.

[8] Compare line 1797 in the Reference and the Limited/No International Cases, http://www.eia.doe.gov/oiaf/servicerpt/s2191/excel/s2191bivnoi.xls.

[9] Specifically, the EIA reference case assumes: (1) a population growth of 0.9 percent per year from 2006 through 2030—four-fifths the historic average of 1.1 percent over the past 45 years; (2) real per capita income growth of 1.6 percent per year—27 percent lower than the historic 2.2 percent growth rate; and (3) emissions growth of 0.7 percent from 2006 through 2020 and 0.4 percent thereafter—half to three-quarters less than the historic 1.6 percent emissions growth rate.

[10] For further discussion, see MIT, The Future of Coal: Options for a Carbon Constrained World, 2007, http://web.mit.edu/coal/The_Future_of_Coal.pdf

[11] Energy Information Administration, *Annual Energy Outlook 2008* (Early Release), Electricity Generation, http://www.eia.doe.gov/oiaf/aeo/excel/figure7_data.xls

[12] Mark Clayton, "New Coal Plants 'Bury' Kyoto: New greenhouse gas emissions from China, India, and the US will swamp cuts from the Kyoto Treaty," *Christian Science Monitor*, December 23, 2004, http://www.csmonitor.com/2004/1223/p01s04-sten.html

[13] "EU Ponders Carbon Tariffs on Imports," Spiegel Online, January 8, 2008, http://www.businessweek.com/globalbiz/content/jan2008/gb2008018_121679.htm?chan=globalbiz_europe+index+page_top+stories

[14] International Energy Agency, Energy and Poverty, 2002, http://www.iea.org/textbase/nppdf/free/2002/energy_poverty.pdf

[15] "A different sort of emergency," The Economist, April 17, 2008, http://www.economist.com/opinion/displaystory.cfm?story_id=11058143

[16] George Monbiot, "An Agricultural Crime Against Humanity: Biofuels could kill more than the Iraq war," November 6, 2007, http://www.monbiot.com/archives/2007/11/06/an-agricultural-crime-against-humanity/

[17] Missy Ryan, "Biofuels Halt Would Ease Food Prices—Ag Group," Reuters News Service, April 30, 2008, http://www.planetark.com/dailynewsstory.cfm/newsid/48157/story.htm

[18] World Bank, World Economic Outlook 2008, p. 60, http://www.imf.org/external/pubs/ft/weo/2008/01/pdf/text.pdf

[19] Manuel Roig-Franzia, "The Culinary and Cultural Staple in Crisis," Washington Post, January 27, 2007, http://www.washingtonpost.com/wp-dyn/content/article/2007/01/26/AR2007012601896_pf.html

[20] Associated Press, "Global Warming Spurs New Race for Northwest Passage," March 26, 2007, http://www.foxnews.com/story/0,2933,261240,00.html

[21] Open Europe, Europe's Dirty Secret: Why the EU Emissions Trading Scheme Isn't Working, August 2007, http://www.openeurope.org.uk/research/etsp2.pdf

[22] NOAA Satellite and Information Service, Thermohaline Circulation, http://www.ncdc.noaa.gov/paleo/ctl/thc.html

[23] Schwartz and Randall, p. 2.

[24] Schwartz and Randall, p. 5.

[25] Lamont-Doherty Earth Observatory, Abrupt Climate Change, http://www.ldeo.columbia.edu/res/pi/arch/examples.shtml

[26] D.C. Barber et al. 1999. Forcing of the Cold Even 8200 Years Ago by Catastrophic Drainage of Laurentide Lakes. Nature 400: 344-348, http://cgc.mcan.gc.ca/c14/cold_event_e.php

[27] E. Rignot and P. Kanagaratnam. 2006. Changes in the Velocity Structure of the Greenland Ice Sheet. *Science*, Vol. 311: 986-990, http://www.sciencemag.org/cgi/content/abstract/311/5763/986

[28] Richard Kerr, Global Climate Change: False Alarm: Atlantic Conveyor Belt Hasn't Slowed Down. Science. 17 November 2006, 1064a, http://www.sciencemag.org/cgi/content/full/314/5802/1064a
[29] "Overturning Ocean Hype," *World Climate Report*, October 13, 2006, http://www.worldclimatereport.com/index.php/2006/10/13/overturning-ocean-hype/
[30] Latif et al. 2005. Is the Thermohaline Circulation Changing? J. Climate, http://luv.dkrz.de/publications_2005/pub_291_329.pdf
[31] IPCC, AR4, Chapter 5, Observations: Oceanic Climate Change and Sea Level, p. 387, http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter5.pdf
[32] Seager, R., D.S. Battisti, J. Yin, N. Gordon, N. Naik, A.C. Clement, and M.A. Cane. 2002. Is the Gulf Stream responsible for Europe's mild winters? 2002. *Quarterly Journal of the Meteorological Society* 128: 2563-2586.
[33] Richard Seager, "The Source of Europe's Mild Climate: The notion that the Gulf Stream is responsible for keeping Europe anonymously warm turns out to be a myth," *American Scientist*, Volume 94, pp. 340-341.
[34] Anderson. Climate Change and Sea Level Rise. Science. 17 March 2007: 1803-1804, http://www.sciencemag.org/cgi/content/full/315/5820/1803
[35] IPCC, AR4, Summary for Policymakers, p. 17, http://www.ipcc.ch/ipccreports/ar4-wg1.htm
[36] Zwally et al. 2002. Surface Melt-Induced Acceleration of Greenland Ice-Sheet Flow. Science 297: 218-222, http://www.sciencemag.org/cgi/content/abstract/297/5579/218
[37] Joughin, I., et al. 2008. Seasonal speedup along the western flank of the Greenland Ice Sheet. Science*express* 10.1126/science.1153288. For a useful review, see http://www.co2science.org/articles/V11/N19/EDIT.php
[38] Kerr, Glaciology: Greenland Ice Slipping Away but Not All That Quickly. Science. 18 April 2008: 301, http://www.sciencemag.org/cgi/reprint/sci;320/5874/301.pdf
[39] IPCC, Climate Change 2001: The Scientific Basis, Chapter 10, p. 678, http://www.grida.no/CLIMATE/IPCC_TAR/wg1/pdf/TAR-11.PDF
[40] Berge-Nguyen, M., A. et al. 2008. Reconstruction of past decades sea level using thermosteric sea level, tide gauge, satellite altimetry and ocean reanalysis data. *Global and Planetary Change*, **62**, 1–13. Reviewed by World Climate Report, "Slower Sea Level Rise," May 6, 2008, http://www.worldclimatereport.com/index.php/2008/05/06/slower-sea-level-rise/
[41] Ronald Bailey, "Stern Measures: Averting climate change is surprisingly affordable. Or is it?" ReasonOnline, November 3, 2006, http://www.reason.com/news/show/116401.html

The CHAIRMAN. And our final witness, Kent Hughes Butts, a professor of political-military strategy at the U.S. Army War College. Dr. Butts previously taught at the U.S. Military Academy, and is the author of Climate Change: Complicating the Struggle Against Extremist Ideology. And he has a chapter in the recent book, Global Climate Change: National Security Implications.

We welcome you, Dr. Butts.

STATEMENT OF DR. KENT HUGHES BUTTS, PROFESSOR, POLITICAL-MILITARY STRATEGY, CENTER FOR STRATEGIC LEADERSHIP, U.S. ARMY WAR COLLEGE

Mr. BUTTS. Chairman Markey, Chairwoman Eshoo, members of the committee, I am honored to be able to contribute to the hearings of the committee on the recent NIA on national security implications of global climate change to 2030. I appreciate the opportunity to respond to your questions concerning the NIA, the concerns of the military planners, and how the intelligence and military communities could plan for the various climate change scenarios.

My testimony today reflects my personal views, and does not necessarily reflect the views of the Army, the Department of Defense, or the administration.

Climate change has surfaced as a critical security issue in the post-Cold War era. While conflict between nation-states remains central to security studies, security strategists now see that regional stability depends on governments maintaining legitimacy and meeting the basic needs of their populations.

The effects of climate change can overwhelm the capacity of fledgling democracies to meet those needs. Because climate change may worsen existing tensions and help destabilize regions, it is a worthy topic for Intelligence Community research, military planning, and interagency cooperation.

I found the NIA to be a fine effort. It is broad in its approach and includes the various levels of resolution concerning global climate change and security. The strategic issues were given appropriate emphasis, and the NIA spells out regional effects that could lead to instability and conflict. In this way, it encourages the security community to explore proactive approaches to security issues.

Because of the breadth of the topic, the NIA needed to highlight many significant areas that would warrant their own assessments. One of these areas is determining the regional implications of global climate change for U.S. national security.

Future assessments could articulate U.S. national security interests in each region and evaluate the implications of climate change for those interests. Where are there threats? What opportunities are created?

While much environmental security and climate change data is open source, there are many regions where data is currently unavailable or limited. The capacity of individual governments to mitigate or adapt to climate change effects would be difficult to discern, and a proper topic for future Intelligence Community research.

In terms of relations with China, the United States is import-dependent for petroleum and mineral resources and finds itself com-

peting with China for influence and minerals access in two critical regions of the world where global climate change is increasingly apparent, the Middle East and Africa.

However, the impacts of climate change create common interests among countries, as well as competition. Because the United States is similarly dependent upon these two regions for its mineral imports, the two countries, China and the United States, do share a common interest in maintaining stability and ensuring dependable access at reasonable prices.

Cooperation between the United States and China on mitigating the effects of climate change and encouraging the development of adaptation capabilities in mineral-producing regions are significant areas of cooperation that could serve as confidence-building measures between the two powers. This could also ensure a stable supply of mineral resources to an already tight world market and promote regional stability. State political systems unable to meet the demands placed upon them by the populations struggle to maintain legitimacy and power and invite the introduction of extremist ideology.

Global climate change places additional demands upon political systems that many developing states cannot meet. Scarcities of resources, lack of water, reduced agricultural capacity create underlying conditions that terrorists seek to exploit. Food riots in Cairo at a time when members of the Muslim Brotherhood are running for election demonstrate the problem.

Military planners are responding to the demands of their leaders for proactive approaches to these issues and the underlying conditions of terror. Planning for the impacts of global climate change in the Intelligence and Military Communities should balance high-impact, low-probability scenarios with low-probability, high-impact scenarios. It is important to plan for low-probability, high-impact events to identify the long lead time responses necessary to ensure U.S. national security interests.

Such planning has the additional value of indicating to vulnerable countries that the U.S. takes threats to their existence seriously. As the military has learned on the battlefield, security planners need to prepare for what the threat can do, not just what the threat is likely to do.

The CHAIRMAN. Dr. Butts, we appreciate your testimony, and each of the other witnesses.

[The statement of Mr. Butts follows:]

Testimony of

Dr. Kent Hughes Butts

Before the Joint Public Hearing of the
Select Committee of Energy Independence and
Global Warming and the Intelligence Community Management Subcommittee of the House
Permanent Select Committee on Intelligence

US House of Representatives

25 June, 2008

I am honored to be able to contribute to the hearings of the Committees on the recent National Intelligence Assessment (NIA) on the National Security Implications of Global Climate Change to 2030. I appreciate the opportunity to respond to your questions concerning the NIA, the concerns of military planners regarding climate change, and how the intelligence and military communities should plan for the various climate change scenarios. My testimony today reflects my personal views and does not necessarily reflect the views of the Army, the Department of Defense, or the Administration.

Climate change has surfaced as a critical security issue in the post Cold War era. While conflict between nation states remains central to security studies, security strategists now see that regional stability depends on governments maintaining legitimacy by meeting the basic needs of their populations. The effects of climate change can overwhelm the capacity of fledgling democracies to meet those needs. Because climate change may worsen existing tensions and help destabilize regions, it is a worthy topic for intelligence community research, military planning, and interagency cooperation.

My comments are informed by my experience in the field of environmental security. In the 1980s, I served as a defense attaché and security assistance officer in Africa where I dealt with the humanitarian assistance and security implications of massive cross-border migrations of refugees fleeing drought and conflict in Mozambique. In the 1990s, I co-chaired the NATO Environmental Security Pilot Study Meetings and served as a member of the US delegation to the OECD environmental security meetings in Prague. Since then, I have had the opportunity to help the Combatant Commands develop environmental security engagement programs aimed at promoting sustainability, stability and multilateral cooperation in their areas of responsibility, and work with the intelligence community on efforts to explore the links between environmental change and security.

National Intelligence Assessment (NIA)

I was asked to review the NIA in preliminary and final forms and received briefings from its lead authors earlier in the process, when they sought feedback on their methodology from the military security community. I found the NIA to be a fine effort that is broad in its approach and includes the various levels of resolution concerning global climate change and security. The strategic issues are given appropriate emphasis, and the NIA spells out regional effects that could lead to instability and conflict. In this way, it encourages the security community to explore proactive approaches to security issues. One of the weaknesses of the US approach to foreign policy has been its reactive nature and lack of emphasis on taking preventive action. While the Bush administration National Security Strategies (NSS) emphasize three pillars for protecting US national security interests: defense; diplomacy; and development, the largely reactive defense component receives the lion's share of resources, and the diplomatic and development functions are reduced to seeking reprogramming authority from defense to accomplish their mission. The NIA provides a powerful justification for increasing the funding for the other two NSS pillars and seeking to mitigate climate change affects before they could lead to costly humanitarian crises, intrastate conflict, regional instability, or tensions between the major powers.

Because of the breadth of its topic the NIA needed to highlight many significant areas that would warrant their own assessments. One of these areas is determining the regional implications of global climate change for US national security interests. Such an assessment could follow the approach of previous US National Security Strategies by articulating US national security interests in each region, then evaluating the implications of climate change for those interests: where are there threats; what opportunities are created? There should be much interest in the new administration and Congress concerning preventive defense and peace building activities. Environmental security issues such as climate change are excellent candidates for such an endeavor. The intelligence community could prepare for that interest by publishing an intelligence document that points out the benefits of using climate change as a catalyst for multilateral and other forms of cooperation. Such confidence building measures can be dedicated toward encouraging stability, and building governmental capacity and legitimacy. While much environmental security and climate change data is open source, there are many regions where data is currently unavailable or limited. The capacity of individual governments to mitigate or adapt to climate change affects would be difficult to discern and a proper topic for intelligence community research.

Military Planners and Climate Change: Terrorism and China

The US relationship with China is the subject of intense debate in both the United States and in China. Much of the discussion centers on the implications of China's economic growth. China is no longer autarkic and must increasingly import large quantities of industrial minerals and materials and energy resources to sustain an economy that is growing at approximately 10 percent annually. So too, the United States is import dependent and finds itself competing with China for influence and minerals access in two critical regions where the effects of global climate change are increasingly apparent, the Middle East and Africa. Military planners have no choice but to concern themselves with the competition for increasingly scarce resources and the effects of climate change on that competition.

There is no wall to protect China from global climate change. Domestically, China is already feeling the effects of climate change on its economic growth. China is water stressed in many

critical areas; large areas around Beijing have been removed from irrigation due to over pumping of water resources and subsidence. Increasingly powerful storms bring devastating flooding to coastal areas and southern China. The health effects of pollution from coal-fired power plants on the workforce are increasingly problematic. However, the international effects of climate change may have a more direct impact on China's economic growth.

The impacts of climate change create common interests among countries as well as competition. The Middle East and Africa are two climate stressed regions that provide the essential resources for the Chinese economy. Ariel Sharon, Boutros Boutros-Ghali, and Yitzhak Rabin have all spoken forcefully about the potential for water scarcity and conflict in the Middle East. Africa, where the effects of climate change are most profound and which leads the world in extra deaths from climate change, has the world's largest reserves of the strategic minerals chromium, cobalt, platinum and manganese, and already supplies 30 percent of China's oil imports. Because the United States is similarly dependent upon these two regions for its mineral imports, the two countries share a common interest in maintaining stability and ensuring dependable access at reasonable prices. Cooperation between the United States and China on mitigating the effects of climate change and encouraging the development of adaptation capabilities in mineral producing regions are significant areas that could serve as confidence building measures between the two powers. This could also ensure a stable supply of mineral resources to an already tight world market and promote regional stability.

The United States has done well at attacking and disrupting terrorists and their organizations, and defending the homeland. It has done less well in a struggle against terrorist ideology that threatens moderate Muslim regimes. Many countries that face a terrorist threat suggest that the United States must place more emphasis on winning the ideological struggle if it is to succeed in the struggle against terror. State political systems unable to meet the demands placed upon them by the population struggle to maintain legitimacy and power, and invite the introduction of alternative or extremist ideology. Global climate change places additional demands upon the political system that many developing states cannot meet. Scarcities of resources, lack of safe water, reduced agricultural capacity; widespread disease and poverty create underlying conditions that terrorists seek to exploit. According to the World Bank, intrastate conflict is 15

times more likely to occur in poor countries than in the industrialized countries. Food riots in Cairo at a time when members of the Muslim Brotherhood are running for election demonstrate the problem.

Climate change fans the fires of regional instability and creates opportunities for terrorists. According to the 9/11 Report, "When people lose hope, when societies break down, when countries fragment, the breeding grounds for terrorism are created." United States interests turn on regional stability. Climate change issues are now recognized as a multiplier for regional instability and conflict, exacerbating tensions resulting from religious, ethnic, and other local differences such as socio-economic disparities between rural and urban areas, rapid economic development, and border disputes.

Military planners are responding to the demands of their leaders for proactive approaches to issues such as competition with China and the underlying conditions of terror. The costs of the Iraq and Afghanistan wars are encouraging fresh thinking about preventive defense in addressing issues that could destabilize regions and lead to conflict. The NIA and the Center for Naval Analysis Climate Change and Security Report are not alone in addressing the climate change and security link. DOD Directive 3000.05 has prioritized stability operations by US military forces and increased the number of military planners and developers of doctrine in this emerging area, thus creating an attentive audience for these products. What is needed is increased priority on identifying and addressing the security effects of global climate change, to include increasing funding for such integral agencies as the Department of State and USAID, and a strong mandate for interagency cooperation that would further encourage military leaders to develop the capacities of host nation militaries for supporting civil authority in addressing climate change issues.

Prioritizing Climate Change Scenarios

Planning for the impacts of global climate change in the intelligence and military communities should balance high impact, low probability scenarios with low probability, high impact scenarios. It is important to plan for low probability, high impact events to identify the long lead

time responses necessary to ensure US national security interests. Such planning has the additional value of indicating to vulnerable countries that the US takes the threat to their existence seriously. As the military has learned on the battlefield, security planners need to prepare for what the threat can do, not just for what the threat is most likely to do. Planning is cost effective and must be performed to identify gaps in preparedness and vulnerabilities within the narrow window during which mitigating steps may be possible. Without such planning and analysis, the necessary debate over allocating scarce resources and developing new predictive models and technologies is much less likely to occur.

Planning for and working with allies to mitigate the high probability, low impact climate change scenarios could receive early emphasis as they provide a more immediate return on investment, but not at the total exclusion of lower probability events. The communication and trust with allies and vulnerable developing countries built by cooperative efforts to develop mitigation and adaptation capabilities reinforces existing processes and provides a framework for addressing high impact, low probability events. Cooperative efforts to develop mitigation and adaptation capabilities build communication and trust with allies and vulnerable developing countries. Emphasizing this high probability strategy will pay immediate benefits by providing critical support to sustainable development and the actions necessary to prevent failed states. Addressing the high probability "close in" targets creates a framework for monitoring and addressing potentially catastrophic low probability, high impact scenarios.

The National Intelligence Assessment on National Security Implications of Global Climate Change to 2030 makes a significant contribution to US national security by reinforcing the security dimensions of climate change and encouraging its further inclusion in US national security planning. As I have indicated there is a pressing need for more intelligence community research into the emerging geopolitical vulnerabilities associated with this phenomenon.

The CHAIRMAN. There are now six roll calls pending upon the House floor that will necessitate all of our Members having to go over there. So what we are going to do now is go to a round of 2 minutes of questioning for each of the members here.

And we will begin by recognizing Chairwoman Eshoo for her round of 2 minutes.

Ms. ESHOO. Thank you, Mr. Chairman. I don't know; this button is broken on this.

Thank you to each one of you for your expertise that you have brought to us and for your magnificent service to our country.

Vice Admiral Gaffney, I would like to ask you the following question—and I have more, and I am going to put them in writing. You represent the thinking of the military. That brings an enormous amount of weight, as it were, to the subject matter at hand.

What do you recommend, given all of the discussion, obviously the knowledge that you have—and I would read into the record all of your background. I mean, after reading this, no one can say this man does not know what he is talking about. I mean, this is incredible, the role of the military in this.

What would you advise our committee in terms of entwining—intertwining the challenges, the national security challenges relative to climate change and the role of the U.S. military in the planning and the addressing of this enormous challenge that we have?

Admiral GAFFNEY. Thank you, Madam Chairwoman.

First of all, I would recommend that the combatant commanders in the regional theaters consider environmental change, climate change in their planning, both for the short term, but also for the long term. Likewise, planners inside the Defense Department that make investments in future capabilities should consider this for the long term.

I also believe, and I think I said this, when you are doing planning regionally it should not be these long lazy curves that one sees sometimes presented by scientists, but much more regionally specific. And when you get to that, I think we need to collect the best data possible from every agency of government. And I have seen that both the Defense Department and the Intelligence Community have data, that they are already collecting as part of their regular mission, that should be reviewed to see if it is useful for this particular issue.

Ms. ESHOO. Thank you.

The CHAIRMAN. The gentlelady's time has expired.

The gentleman from California, Mr. Issa.

Mr. ISSA. Thank you, Chairman. I will be equally brief.

Dr. Lewis, Dr. Butts, you seem to have a common theme. The theme was be careful what you wish for and do, because then you have to figure out how to mitigate what you did to mitigate. Fair assumption?

Mr. LEWIS. Yes.

Mr. ISSA. Should this committee, as we tasked, okay, what apocalyptic events could happen if the temperature rises 7 degrees, or as I suggested earlier, 1975 scenario, it drops 7 degrees—it seems to have the same effect.

Given that and given the assumption that today's prediction is that it is a clear rise in temperature from CO_2 emissions—that is sort of the given truism today—should we ask what CO_2 abatements are most efficient with the least offsets and in what locations and begin fast-implementing them?

And I will give you a quick example. We can deploy wind energy anywhere in the world and the proliferation is limited. We can deploy nuclear here in the U.S. if we have the will to, and proliferation would be nonexistent.

But you flip that around, okay: Can you do the same inverse? Of course not. So should we be asking the question of our best think tanks, in addition to agencies and so on, how do we get to zero emissions as quickly as possible with the least offsets and weigh those?

And secondly, because the time is limited, don't we also have to ask what the impacts of rising food prices and so on are, and be just as concerned that those food prices are going to rise if we do exactly what we are doing today with no change? In other words, if we ignore global warming and it doesn't happen, we still have some very dangerous scenarios.

Mr. LEWIS. I guess I would have to say "yes." I mean, that was a very multipart question.

But, you know, it is interesting; Congress may not be able to enact a cap-and-trade program yet, but it certainly has the power of the purse. And it was interesting, as pointed out earlier, that we are spending $3 billion on energy technologies in this political climate in which people are saying that, you know, we could have some low-probability events that could actually destroy civilization.

So, I mean, I am just wondering what it says, really, about political reality that we can have a rhetoric that I would consider alarmist, you know, that this is a civilization-ending peril, and yet we are only prepared to spend $3 billion to deal with it. However, what we would really like to do is impose a regulatory system on the economy that would force people to spend trillions.

There seems to be a disconnect there.

The CHAIRMAN. The gentleman's time has expired.

The Chair recognizes the gentleman from New York, Mr. Hall, for 2 minutes.

Mr. HALL. Thank you, Mr. Chairman.

I am interested in Professor Butts's assertion that the threat of climate change could provide opportunities for multilateral cooperation. Sort of the flip side of the coin that the former Secretary from the UK, Mrs. Beckett, made in terms of climate change being a threat multiplier.

Do you envision technology transfer programs, water security agreements, coordinated disaster response efforts? Could you elaborate on those multilateral cooperations?

Mr. BUTTS. Sir, all of those would qualify. I think that the mechanisms of our National Security Community could reach out to other nations and seek areas of cooperation and build confidence—CBMs, confidence-building measures. So in areas where there may be border disputes, there may be cooperation on dealing with watershed management. In areas where there are common interests, as I mentioned with China and the United States, how might we

work together to improve development in those areas, help the governments maintain themselves in power, and prevent failed states that terrorists might take advantage of?

Mr. HALL. Thank you.

And I would just like to—I know time is short here. I just want to thank the Admiral for quoting Mr. Gingrich that we cannot afford to be wrong about this. And I believe personally that I would rather be wrong on the side of doing what it takes to mitigate climate change, because in the process of doing so, we will be creating new technologies and new jobs and new industries and renewable technologies here, hopefully keeping the jobs here at home and reversing that flow of dollars that has been bleeding us for the last several years and putting us in an insecure economic and national security position.

And I yield back.

The CHAIRMAN. I thank the gentleman very much.

I thank the panel for their tremendous contribution today. We apologize to you, but we did learn today that the Intelligence Community believes that global warming creates conditions that foster terrorism. That shocking conclusion should give even greater reason to act promptly on climate change legislation.

Unfortunately, the harsh truth has been papered over in public testimony. This administration has a multicolor scheme for warnings—red, orange, yellow, green—but the administration uses another color on climate change, and that is whitewash. It does a great disservice to the American people to obscure the truth behind the cloak of phony secrecy claims.

We need, on a bipartisan basis, to have this entire report declassified so that we can have the full-ranging debate not only that the United States needs, but the entire world needs so that we can take the action now before it is too late.

We thank each of you for your contribution today. We apologize to you for the truncated nature of the hearing. But with that, this hearing is adjourned with a minute and 38 seconds yet to go a quarter of a mile over to the House floor. Thank you.

[Whereupon, at 12:31 p.m., the committee was adjourned.]

Rt. Hon. Margaret Beckett (Former Secretary of State for Foreign and Commonwealth Affairs of the United Kingdom)

Responses to questions following on testimony given before a Joint Hearing of the

House Permanent Select Committee on Intelligence

Subcommittee on Intelligence Community Management

and

House Select Committee on Energy Independence and Global Warming

U.S. House of Representatives

Washington, DC

September 8, 2008

The answers to the questions below represent my own personal views.

1. **When we look at Global Warming, we simply must look at Global Solutions. What do you suggest we do to engage China and India and others in the process of reducing carbon emissions?**

The most important steps that we can take are

i. to spread understanding, not just of the general impact of climate change but of the specific likely impacts in China and India themselves. This is increasingly well understood in China, perhaps less so in India.
ii. to make it clear that as the Stern Report demonstrates, countries like China and India are not required to forfeit growth capacity in order to tackle climate change if, as we all must, they are able to move towards a low carbon economy
iii. China and India are among many countries who take very seriously the principle of action which is common but differentiated – in other words as the UN Convention identifies, all must take action if we are to avoid dangerous climate change but that those like the developed countries, which have the greatest capacity to do so, should move first and lead by example
iv. We should offer practical help to such countries. For example, the EU is working with China on a demonstration coal-fired power plant with carbon capture and storage. India has probably more clean development mechanism projects (CDM)

than any other developing country. But it is we, the developed countries, who can do most to create the markets for low carbon goods.

2. **What do you think is a reasonable, practical timeline for reduction of our dependence on fossil fuels? How does this timeline differ between OECD and developing countries**?

The most important timeline is that created by the science of climate change in which scientists have demonstrated that if we are to avoid a global temperature rise of more than 2 degrees C (itself with substantial impacts) we should already have begun to reduce our dependence on fossil fuels. The recent pattern of fuel prices encourages us all to realize that energy security and climate security are two sides of the same coin. Greater energy efficiency will be part of the mix to get us off the oil hook but we cannot meet energy demands through efficiency and renewables alone. It is essential for clean coal, through carbon, capture and storage, to be a core part of the answer.

We must also recognize that the demand for energy will continue to grow as world population grows. The IEA has identified that to achieve a 50% global cut in emissions (minimum required to have a chance at limiting to 2C) we "would need a virtual decarbonisation of the power sector. Given the growing demand for electricity, this would mean that on average per year 35 coal and 20 gas-fired power plants would have to be fitted with CO2 capture and storage (CCS) technology, between 2010 and 2050 at a cost of USD 1.5 billion each. Furthermore, we would have to build an additional 32 new nuclear plants each year and wind capacity would have to increase by approximately 17.500 turbines each year."
[http://www.iea.org/Textbase/press/pressdetail.asp?PRESS_REL_ID=263]

The IEA has also drawn attention to the potential of solar power and some studies have suggested that use of solar power in some of the most desertified areas of the world could make an enormous contribution to meeting energy demand.

3. **If the temperature is going to rise despite any immediate steps to curb carbon emissions, do you think that adaptation should be the primary focus of the United States until the technology to mitigate emissions, while still satisfying our energy demands, have been developed**?

The danger of too much focus on adaptation is that you could be running to stand still. This would make too heavy a focus on adaptation a very high-risk strategy. However, although for a time the climate change was bedeviled by an assumption that adaptation and mitigation were mutually exclusive, it is now recognized that they help each other.

IPCC states emissions have to peak within the next 10-15 years and decisions are being taken now about our energy infrastructures which will tie us in to high emissions paths for up to the next 40 years. Emissions from the energy sector (2/3 total global emissions) are predicted to rise by 55% by 2030 [IEA World Energy Outlook 2007] when we need them to have dropped by 25-40% by 2020 (IPCC).

Most studies suggest that we have sufficient technology available now (or near market) to meet the necessary emissions targets. A lot of quick wins are still available from energy efficiency which will, in addition, save homeowners and businesses money.
We cannot afford to wait for new technology that may not appear in time.

4. **What would have a more significant impact on assisting developing nations to deal with climate change: working towards achieving the U.N. Millennium Development Goals or the United States unilaterally imposing a mandatory cap on our greenhouse gas emissions**?

To concentrate on achieving the UN Millennium Development Goals – vital though they are – without taking into account the impact of climate change would put achieving those goals at risk. For example, steps to provide clean water were taken during the UN Water Decade on a not dissimilar scale to those envisaged in the MDGs. But because that work was not undertaken sustainably, it is all to do again.

Similarly, in at least one of the poorer developing countries which have substantial aid flows it has been assessed that at least 25% of the investment made in recent decades has been already been rendered nugatory by climate change which was not factored in to the assessment of those projects.

There is no need to choose between the two. The UK is committed to both a tight cap on emissions and delivery of the MDGs. However, the importance of the example set by developed countries does mean that any action the US takes to cap and reduce emissions could have a substantial impact.

5. **Which clean energy technologies are cost competitive with fossil fuels and/or nuclear at the moment? What is the time frame for these technologies to become competitive with fossil fuels and/or nuclear**?

Few if any of the clean energy technologies are assessed to be "cost competitive" with fossil fuels at present However, the basic comparison of costs fails to include all of the costs generated by the consumption of each energy type, in particular, the costs of damage to the environment. If you included these so-called 'externalities' and the hidden subsidies to the hydrocarbon and nuclear industries the differences in cost are narrowed considerably.
Moreover, these comparisons are, of course, very dependent on the price of fossil fuels themselves.

In addition, as conventional fuels such as oil and gas are depleted and marginal resources are more difficult to extract and process, prices for these fuels are likely to remain high or even increase. On the other hand, as renewable technologies are the subject of more research and commercial deployment, costs can be expected to fall over time.

Moreover, the likely impacts of climate change will include more frequent and intense storms, sea level rise, storm and tidal surges; all of which have potential to impact production levels and so reliability of supply. For example, Hurricanes Katrina and Rita severely hit oil and gas production; 90% of US Gulf of Mexico oil and 80% gas production taken out, and a year later 22% of oil production and 15% of gas were still shut in.

6. **What actions should the federal government take to assist less developed nations build infrastructure to cope with climate change**?

As the US NIA indicated, less developed nations' vulnerability to climate change is linked to their limited capacity to respond. They will need support to adapt to climate change and the costs will be significant.

For example, in some LDCs where the chief economic activity such as mineral extraction is itself heavily dependent on substantial use of water, economic diversification should be part of their defences against climate change, since not only agriculture and living standards would be affected by severe water shortage but economic viability itself. So, specific action to manage the impact of climate change is also needed.

Climate-resilient development and building adaptive capacity will need to be scaled up (e.g. irrigation and social protection schemes); new climate-specific measures will need to be undertaken (e.g. managing the risks of glacier-melt floods or increased desertification); and contingency funding will be required to manage residual impacts of climate change. Ensuring adequate, predictable, and additional financing is available and integrated within development budgets will be critical for climate-resilient development. The cost to the public and private sector could be in the range of tens of billions of dollars per year. The UN's latest Human Development Report estimates that additional adaptation finance needs will amount to US$86 billion annually by 2015. Oxfam puts the price tag at US$50 billion per year, and the UNFCCC puts it at US$28-67 billion by 2030.

7. **How will the current escalating fuel costs affect the military's ability to conduct training operations? How would a federal cap-and-trade scheme further exacerbate these training costs? How much will military preparedness be negatively impacted if the price of energy significantly rises**?

The escalating fuel costs demonstrate the need to get off the oil hook. This is the only sustainable solution, as vulnerability on price fluctuations is itself an increased security risk. This highlights the need to improve the energy efficiency of operations and include lifecycle fuel costs in procurement of equipment. Our own Ministry of Defence is increasing the use of simulators to help reduce fuels costs.

We will face multiple simultaneous crises and conflicts around the world as the impacts of climate change exacerbate existing tensions. The impacts of climate change will reduce our capacity to respond through making the strategic resources harder and more expensive to obtain and, at the same time, place increased demand for responses. We will

find it harder to afford the needed levels of security unless we limit dangerous climate change and a cap and trade scheme is part of the solution.

8. **What actions could the federal or state governments take to encourage production and purchase flexible fuel vehicles, hybrids, clean diesel or hydrogen automobiles**?

We need to encourage development of clean technology but it may be preferable to set goals for the private sector and encourage them to choose the technologies rather than government prejudicing the choice of one type over another. Such an approach worked both better and faster when the world community chose it to tackle the hole in the ozone layer. The EU is introducing a 130g/km limit by 2015 (to be phased in from 2012) in order to encourage deployment of low-carbon vehicles.

9. **Some legislative proposals would place a tariff on carbon-intensive goods from developing countries that do not have mandatory greenhouse gas restrictions. How would a trade war that could result from such a proposal affect international relations between the United States and countries that would most likely be affected, namely China and India**?

Positive action to incentivise the investment in low carbon goods and services is what is needed rather than negative actions like tariffs. Additionally, we need to build mutual trust in order to achieve a global low carbon economy. Tariffs would jeopardize such an achievement. Any trade war tends to be damaging. Again this is why developed countries need to take a leadership position to show that we are serious about low carbon.

10. **How would achieving certain international goals, such as the Millennium Development Goals, change the possible impacts of climate change in poor regions, such as Africa**?

Climate change poses the most serious threat to development and the Millennium Development Goals. Without successful global action to reduce and stabilise emissions and support for developing countries to adapt to the inevitable impacts of climate change, poor regions such as Africa will suffer first and hardest. (also see answers to the previous questions).

11. **Has the United Kingdom done a similar report to the National Intelligence Analysis Dr. Fingar discussed**?

The UK Ministry of Defence and the relevant agencies have been keeping the impact of climate change under review and monitoring its implications for some considerable time. The UK's recently produced Security Strategy states that climate change is potentially the greatest threat to global stability and security, and therefore UK national security.

The UK Government is working to deepen the evidence base and plans to do further specific studies on this topic. The first will be a joint study with the French Government on the Sahel region.

12. **Given your presentation to the U.N. Security Council last year, aren't there enough U.N. agencies, such as the World Food Program, that are already examining how climate change will affect long-term international policies and shouldn't the Security Council focus on matters of immediate urgency, such as preventing Iran from security nuclear material**?

These issues are not mutually exclusive since while the Security Council must deal with evident imminent threats, it would be derelict in its duty if it ignored long-term dangers, especially any whose impact would be planet-wide.

As Foreign Secretary, I was heavily engaged in the issue of Iranian access to nuclear technology, but one aspect of climate change which is causing much wider concern is the impact of access to nuclear material and technology on non proliferation, if climate change leads to a much more widespread development of civil nuclear power.

Climate change is an urgent issue which if not addressed has the potential to impact across all other security issues and exacerbate the problem.

13. **Why hasn't the European Union's ETS stemmed growth of real emissions? If the ETS were to extend to the entire economy, how much would per capita emissions have to decrease and what would this cost**?

It is important to recognize that ETS schemes are still at a fairly early stage of development. For example, the UK was, I believe, the first country to introduce a pilot economy wide ETS. This was then subsumed into the somewhat different EU scheme. Phase One of the EU ETS was always intended to be a learning phase and it will be difficult to assess the picture across the EU until the end of the phase.

The results to date have shown the trading mechanism is viable and that the institutional framework is sound. We believe this is a solid base to build on for the future. In the UK compliance has been excellent. In 2006 all operators surrendered sufficient allowances within the deadlines. However, in the UK emissions have been above the cap. This means that the UK installations have had to purchase allowances from other Member States. These allowances are effectively emission reductions made elsewhere, which UK installations have paid for.

As there was a large overall surplus and we don't know the quality of the projections data used in other Member States, it is difficult yet to assess the value of these emission reductions.

A further complication in making such an assessment at present is that there is a time-scale involved in implementing new abatement technology and many installations are carrying out ongoing programs of improving energy efficiency that began before 2005.

THE SELECT COMMITTEE ON
ENERGY INDEPENDENCE AND GLOBAL WARMING

Dear Vice Admiral Gaffney:
Following your appearance in front of the Select Committee on Energy Independence and Global Warming, members of the committee submitted additional questions for your attention. I have attached the document with those questions to this email. Please respond at your earliest convenience, or within 2 weeks. Responses may be submitted in electronic form, at aliya.brodsky@mail.house.gov. Please call with any questions or concerns.

GAFFNEY ANSWERS IN BOLD BELOW 8/20/08

Thank you,
Ali Brodsky

Ali Brodsky
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Select Committee on Energy Independence and Global Warming
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1. When we look at Global Warming, we simply must look at Global Solutions. What do you suggest we do to engage China and India and others in the process of reducing carbon emissions

   I did not cover this topic in my testimony. In my view getting them to make (and share) comprehensive measurements of atmospheric properties of interest will help inform them, but sharing with them our own data on their emissions and possibly other climate related data (loss or arable land, loss of coastline, glacial melt, etc.) will be useful in a "you can run but you can't hide" sense.

2. What do you think is a reasonable, practical timeline for reduction of our dependence on fossil fuels? How does this timeline differ between OECD and developing countries?

   I am not qualified to answer this question.

3. If the temperature is going to rise despite any immediate steps to curb carbon emissions, do you think that adaptation should be the primary focus of the United States until the technology to mitigate emissions, while still satisfying our energy demands, have been

developed? **Certainly the US is best able to adapt to global change (warming or cooling, migration of people, agricultural change, etc.). In my testimony, I imply that if global change trends continue then the real issue for US security is how the least developed countries of the world will cope, since they will be ill-equipped to adapt.**

4. What would have a more significant impact on assisting developing nations to deal with climate change: working towards achieving the U.N. Millennium Development Goals or the United States unilaterally imposing a mandatory cap on our greenhouse gas emissions? **I am not qualified to answer this question.**
5. Which clean energy technologies are cost competitive with fossil fuels and/or nuclear at the moment? What is the time frame for these technologies to become competitive with fossil fuels and/or nuclear? **While I am not qualified to address the economics of this issue, I tend to believe that solar energy, wind energy (on and offshore) and renewable offshore energy technologies can help improve our energy situation. In my opinion, the nation is currently forced to cope with a slow, burdensome and unpredictable set of permitting processes that spurn development of these alternatives. While a fossil fuel, one must look carefully at the abundance of gas hydrates (clathrates) embedded in our offshore, continental shelf areas – methane is clean burning and methane hydrates are abundant, but safe and cost-effective extraction is the issue that needs further study and investment.**
6. What actions should the federal government take to assist less developed nations build infrastructure to cope with climate change? **First we need to refine our measurements using all available sources so we can make credible and geographically-specific predictions of climate change effects region-by-region. Once we have confidence in our predictions we should use that information to educate the least developed nations. I would also suggest that military-to-military discussions about the security consequences of unfavorable global change could draw the attention of the target nation, especially lesser developed nations. We can best do that after including climate change effects planning in regional military-diplomatic plans – a major finding of the CNA study.**

7. How will the current escalating fuel costs affect the military's ability to conduct training operations? How would a federal cap-and-trade scheme further exacerbate these training costs? How much will military preparedness be negatively impacted if the price of energy significantly rises? **I am unable to assign numerical value to these questions. I am not an expert on military logistics or training costs. The CNA Report calls for "improved combat power through energy efficiency" ... CNA Report page 47.**
8. What actions could the federal or state governments take to encourage production and purchase flexible fuel vehicles, hybrids, clean diesel or hydrogen automobiles? **Again, I did not testify on this issue and am not an expert, but in other national ocean advisory forums, I note a growing concern over the slowness, burden and unpredictability of permitting for alternate energy projects (wind, ocean renewables, etc.).**

   As a university president, I am concerned that there are not enough incentives at colleges to adopt energy alternatives, like solar power and AFVs. Enabling universities to invest in these alternatives would be valuable for two reasons: 1) to improve the bottom-line (costs at colleges are growing) and 2) they provide unique opportunities to influence the thinking of thousands of future leaders.
9. Some legislative proposals would place a tariff on carbon-intensive goods from developing countries that do not have mandatory greenhouse gas restrictions. How would a trade war that could result from such a proposal affect international relations between the United States and countries that would most likely be affected, namely China and India? **I am not qualified to comment on this question.**
10. What role should the Intelligence Community play in contributing to policy makers' and the public's understanding of global climate change? **First, I see the Defense <u>and</u> Intelligence (D&I) communities, both, as having a substantial pool of national-class talent, data, instruments and computational devices, and deployed sensors that might be leveraged (incidental their intended primary security missions) to help the nation better understand if and how climate change is progressing. I think this can be done at little additional cost while protecting security. In fact it was done for a decade in the 1990's.**

Second, I am less concerned about Intelligence Community advice to policy makers than I am in the Defense and Intelligence Communities appropriately sharing data they may have collected (be able to collect) with national scientific bodies who will give climate advice to policy makers.

11. You emphasized the importance of collaboration between scientists and the intelligence community to measure "the most critical physical processes of our planet," and you cited the MEDEA project, which involved that collaboration in the 1990s but was cut off after 2000.

    - How would you describe the cost, in terms of national security planning or other lost opportunities, of our government's not listening to our scientists on climate change for the past eight years? **I do not see the statement above and its follow-up question as directly related to each other. I believe the MEDEA project was very successful at low cost and at low risk. I was useful to many scientists, not just those involved in the climate debate. I would have preferred that MEDEA continue, but many measurements have been taken over the last 8 years that might be reviewed. Future sensor design and deployment decisions will be made in our current timeframe; I would hope that the powers-to-be would consider leveraging those security decisions by also considering how they might help unravel climate uncertainties and gain more specificity in regional climate effects predictions.**

12. Even if the United States institutes a mandatory cap-and-trade regime on our economy, there will only be a minimal impact on the global temperature. What steps can the U.S. take to provide immediate stability to developing countries? **I would refer the Committee Staff to my answer to question #6.** Have you conducted any cost-benefit analysis for your recommendations? **No.**

13. Given the limited capacities that our defense and intelligence communities face, if those resources are directed towards observing climate change, where should they be shifted from? **I would not re-direct any D&I resources. I would leverage the capabilities of these communities as they pursue their classic missions. For example:**

    - **I would include their talented people in discussions with American civil scientists;**

- **I would "clear" some civil scientists to be able to see the broad range of D&I capabilities;**
- **I would release classified data [that does not need to be classified any longer] or derive unclassified information from classified data after very deliberate security review;**
- **I would ensure that the climate community informs the D&I communities of its sensor parameter needs thereby giving the D&I communities the opportunities to collect data (incidentally) during ongoing collection activities or consider minor design changes in sensor engineering and deployment.**

All of these I consider low cost leveraging, not re-direction of D&I capabilities.

14. In your testimony, you note that you do not dispute the science or any of the underlying assumptions that accompany the threat of climate change. Considering that there are ranges of temperature variability's and climate repercussions, within the CNA Report, which scenarios did you consider to be most likely? **The CNA Report does not rank scenarios by likelihood of occurrence. The CNA Report was most concerned with the general security implications if lesser developed countries are affected by climate change. I believe an important point the Report makes is that regardless of the certainty of climate scenario predictions (high or low) the effect would be serious enough to warrant careful consideration of climate change in regional military planning.**

15. You call for releasing national security data and information to help civil scientists. Do you have any concerns of releasing classified information or publicizing our intelligence community's capacity? **No. It must include a very deliberate security review process. The MEDEA program of the 1990's worked well, and can serve as a model.**

16. How much raw climate change data is classified? **It is impossible to answer this question. That is why I call for a review of data holdings, much like MEDEA did, in a systematic manner, to determine if there is data on file that may be useful, and to determine if there are future leveraging opportunities.**

17. Have you discussed the challenges of gaining specific regional climate change results with the science community? **I presented the need for more regional specificity in a**

briefing to the climate community in November 2007. Do you recognize the challenges and uncertainties that accompany any sort of climate modeling? **Yes, I was in charge of Navy weather and ocean prediction and also invested in basic and applied research in atmospheric and ocean dynamics models that are widely used by the Navy. In certain aspects of modeling the Navy has been the leader in developing and using global-, basin-, regional- and local-scale models. But, I would say my testimony was presented to stir policy discussion and is not a technical appeal to the numerical modeling or computational fluid dynamics communities.**